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Zak Storey

A TIME TO REFLECT

MAXIMUM PC to me has always been more than just another tech publication. It's got a history and a reputation behind it. From its earliest days as *Boot* magazine, to the heady heights of Gordon Mah Ung's run as editor, to the closure of its website back in 2017, and my own coronavirus-stressed tenure, it's had its fair share of ups and downs.

But honestly, my biggest takeaway from it—and perhaps the biggest reason why I came back to it—is the community. All of you who still subscribe, support us, and write in—whether that's with suggestions, or anger and complaints, or just questions and praise—you continue to make *Maximum PC* better than it was the day before. It's a key part of why I believe it's still so successful. We might not have as much budget as we once did, and the team's much smaller now too, but the fact all of us care so deeply about this place is a credit I think to the work of everyone who came before us, and all of you guys and gals out there who still read these pages today.

That puts me in a difficult position, because I know it's not really our place to make statements on morality, or ethics, or politics, or anything along those lines. That's not what we're here to do. After all, we're tech journalists, and for the majority of you that's where our expertise ends, and rightly so. However, I got into this profession because I wanted to make a difference, I wanted to make the world a better place in my own small way, and I believe wholeheartedly in honesty, and in the First Amendment in its entirety.

I have to tell you then, as *Maximum PC*'s current editor, I'd be doing a disservice if I didn't bring attention to the Black Lives Matter movement. It goes without saying that myself and the team here fully support the peaceful protests and the right to freedom of assembly, and we do hope serious positive change and societal reform comes out of it—that is a sentiment that's echoed by Future, our publisher, as well. In fact, we're not just going to jump on the bandwagon here either; we'll also be readjusting a few things on the back-end too, to hopefully make our own small impact in the best way we can. Our staff writer, Christian, has more to say concerning this in his Lab Note later on in the issue that you can find on page 78. However I'll leave that to him.

I'm not looking for a fight or to upset anyone, I'm just asking you to give it all some thought and think about your actions, and perhaps just do a little research into the matter. After all, keeping an open mind, I have found, is one of the best things you can do in this life, and I think it's that very quality that all of us in the *Maximum PC* community share.

For this issue, we've thrown out the rulebook, and we're producing two builds. Yep, a full 12-pager system on Intel's latest Comet Lake Core i9-10900K, followed up by an impeccably silent audio-editing PC for your home studio. On top of that, we've got a nice look back at the 20 "best" tech fails of this century, and a bevy of reviews, tutorials, columns, and more. I really do hope you stay safe out there, and enjoy the latest issue of *Maximum PC*.

Zak Storey is Maximum PC's *editor and long-time staff member. He's been building PCs since he was 10, and is more than capable of butting heads with the biggest names in tech.*

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THE NEWS

Apple's New Chips

Company to switch to its own ARM designs

APPLE IS TO USE its own designs of ARM processors in all its Macs. Rumors of this move have been floating around for years—actually a decade—but now it's a reality: Apple is dropping the x86 processor, and taking the job in-house. There are, reportedly, three different system-on-a-chip designs in development: "Project Kalamata" as it is called within Apple. The first design is based on the iPhone A14 chip (due to appear in the iPhone 12 shortly). Apple's custom A-series chips are already the best in the business, surpassing ARM's own designs. The chips are to be made by TSMC—Apple has no manufacturing capacity for this—and will use the same 5nm process as the A14.

The first design is expected to have 12 cores: eight high-performance "Firestorm" cores, and four energy-efficient ones. If Apple is serious (it is), then it'll have a full road map of designs mapped out already—you don't work on one generation at a time. All its chip design cycles will be amalgamated into one, cutting across the market sectors.

The ARM-based Macs will stick to macOS. The fundamental differences in the x86 and ARM architectures mean there will be a lot of work to do on the software side to get everything running smoothly. We can expect a couple of years of annoying incompatibilities. The tantalizing goal is software that, in theory, will run on every Apple device, from the iPhone to the Mac Pro. Internal testing of ARM-powered laptops have proved that there are "sizable" gains to be made in the switch, particularly in power consumption, which means quieter and cooler laptops too. It has also been reported that the switch will save Apple between 40-60 percent on the cost of processors, although don't expect that saving to reach the bottom line.

Apple has used various processors over the years, from the original MOS technology and Synertek chips. It then spent years using Motorola and the related PowerPC chips. For the last 15 or so years it has been using Intel silicon. The company has never tied itself to one architecture: It used the best

The company will have the most control over its machines since the first Apple was built.

of what was available. The move to Intel chips, starting in 2006, was a big deal at the time. Apple wasn't happy with the lack of development with the PowerPC chip. The move was finished in 2009, when PowerPC support was finally dropped from macOS. Getting Apple's custom was good news for Intel, but the relationship has been strained recently. Intel's troubles in moving to a 10nm process hasn't helped, or that AMD's Zen now offers more for the money. Apple ditching Intel was always just a question of time.

Computing devices falls roughly into two camps: x86-dominated larger devices, and the ARM-based mobile ones. Each has tried to break into the other market without success. Microsoft's phone business was a disaster, and Intel's mobile chips tanked. ARM processors never gathered the horsepower for larger devices. Apple, ever the willing outsider, is going to cut right across that. It seeks an integrated, unified world, from the phone to the professional desktop. Currently there's a break in Apple's software and hardware between the ARM mobile devices and the Intel Macs. Fixing that break, and pushing processor development in the direction Apple wants, gives the company an unprecedented level of control overs its machines, and if there's one thing that's clear it's that Apple likes to have control.

Could this be the start of a serious threat to the dominance of the x86 architecture? ARM designs have some significant advantages, particularly in producing power per watt. If this can be scaled to desktop levels of performance then x86 could be facing its first serious rival for many years. However, Apple's share of the desktop market is about 10 percent, and the installed base of x86 software is truly vast. What it will do is stir the somewhat moribund waters. If Apple can build a system to embarrass Intel and AMD's best, then it cannot go unchallenged. The big two are particularly vulnerable as devices get smaller. We can expect other big-name laptop makers to try the ARM route in time.

The first fruits of this project are due next year, when we'll see at least one ARM-powered Mac laptop, which will be the most carefully scrutinized Mac for years. **–CL**

> If Apple is serious (it is), then it'll have a full road map of designs mapped out already

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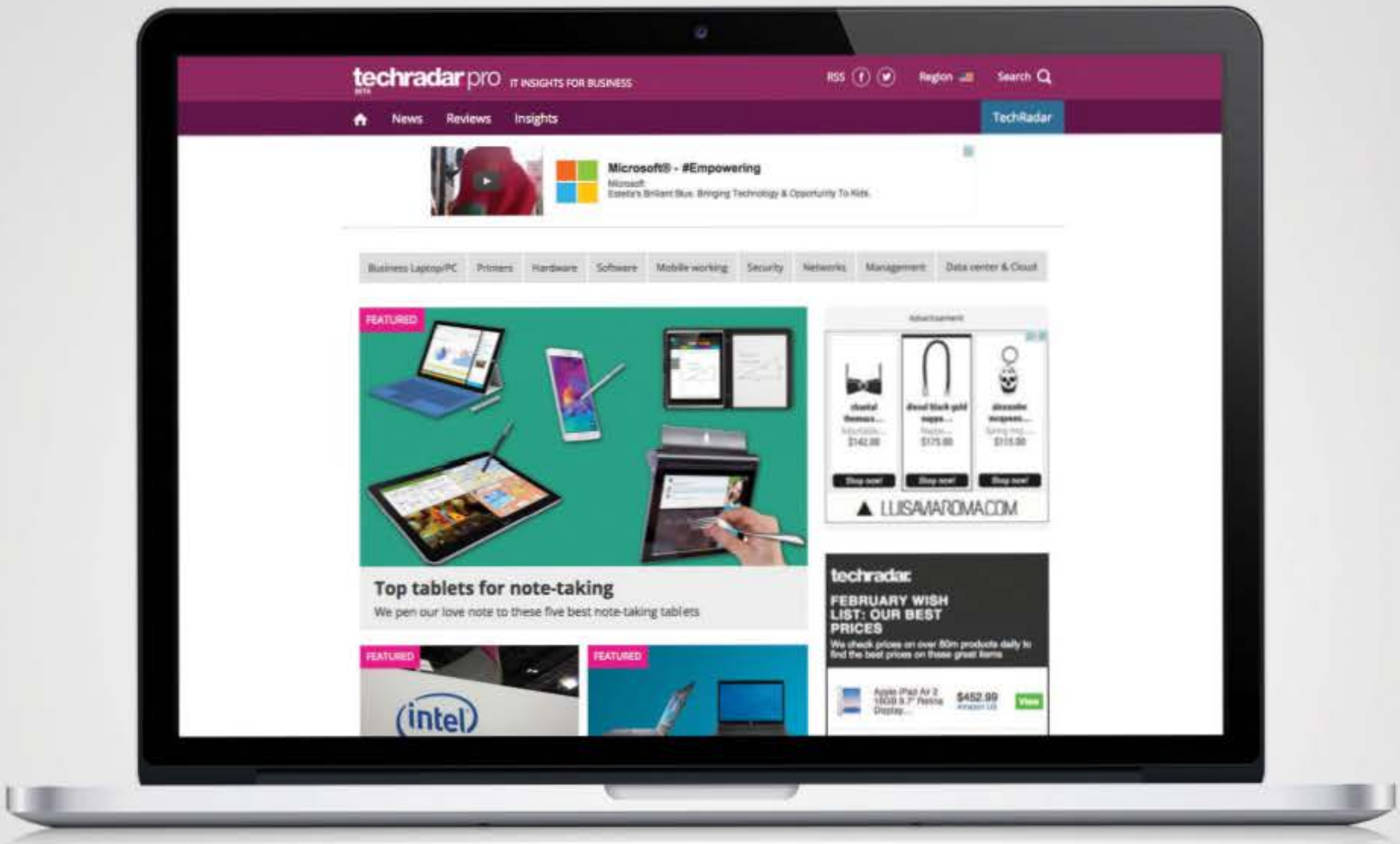
IT INSIGHTS FOR BUSINESS



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INTEL LOSES KEY PLAYER

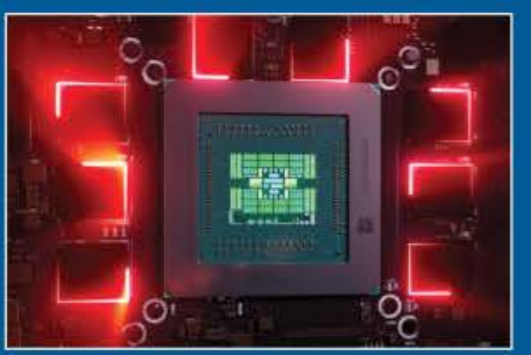
TOP CHIP DESIGNER RESIGNS

INTEL HAS LOST its leading chip architect, Jim Keller, after barely two years at the company. Keller will work as a consultant for six months to help in the transition as Intel shuffles around the heads of it engineering groups. Keller has resigned for undisclosed personal reasons, although it seems amicable enough, with Intel praising his work in an internal memo.

Keller has an impressive work history, including being a big hand in the Zen micro-architecture, Tesla's Autopilot, and Apple's A4 and A5 chips. His loss couldn't come at a worse time for Intel: Just a couple of months ago he was the subject of an article in *Fortune* magazine that said Intel was "betting its chips" on the "mastermind" Keller, who was to be given room to make wide changes at Intel. His truncated tenure at Intel will be keenly felt: It typically takes four years to build a new chip micro-architecture. **–CL**

AMD SAYS YOU NEED 8GB OF VRAM

4GB cards obsolete



IN A BLOG POST AMD pitched a 4GB Radeon RX 5500XT against an 8GB version, and has concluded that the 4GB card is increasingly obsolete for top-flight gaming. The average performance gap at 1440p is under 10 percent. However, for newer, heavy-hitting games the gap is more pronounced. *Call of Duty: Modern Warfare* is 22% faster, and *Wolfenstein II: New Colossus* is 24% faster. That's a fairly significant margin. That gap will only get wider too: The next generation of consoles will both have 16GB. Running a PC version without all that VRAM means a compromise.

A company recommending that you buy a more expensive product is hardly surprising, but AMD does have a point, especially for AAA titles. You'll still need a GPU that can fill that VRAM with useful work, and selling VRAM is profitable, but you certainly want to match your GPU with the right amount. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

GAME GEAR GOES MICRO
Sega has launched a miniature version of its Game Gear in Japan, in four colors with four different games built into each.

LENSES WITH MOJO
Mojo Vision says it has developed a contact lens with a head-up display, using a tiny projector.

GAME WITH NO ENGINE
Nvidia got an AI system to create a *Pac-Man* game, without an underlying game engine, using its GameGAN model.

TRAGEDIES

ANDROID DEFEATED
Setting an image with a non-standard color map as a wallpaper can send your phone into an endless reboot loop.

ISP WARNS USERS
Cox has warned heavy users to cut back data consumption, or it will cut upload speeds across the entire neighborhood. Ouch.

VR EYESIGHT WORRIES
A developer with over 10,000 hours using headsets claims it has degraded his eyesight.

PS5 REVEAL

Mixed reaction as Sony finally shows PS5

WE NOW KNOW what the PlayStation 5 will look like. The black and white box features rounded corners and distinct fins, or wings. There are the near-obligatory blue LED lights too. It certainly looks better sitting vertically. Thankfully it looks nothing like the many bizarre renders we've seen online over the last months. Even so its slightly bold design has attracted some criticism, particularly on Twitter. That bastion of good taste has already run with an ugly duckling meme. There are two designs, one with an optical drive and one without, and the latter is slightly thinner. PlayStation CEO Jim Ryan claimed the company wants to take some risks with design, and it certainly makes the Xbox Series X look like a black block with a light on top, which it is.

We've known the basic hardware specifications for a while now (4K games at 60fps, 3.5GHz Zen 2 CPU and RDNA 2 GPU with 16GB). It'll be here for the holidays, so how much? When the PS4 launched against the Xbox One in 2013, Sony undercut its rival. Microsoft announced a $499 price tag, and the next day Sony announced a $399 one. It has been hoped that Sony would repeat the trick, but that looks highly unlikely now, as the PS5 has some expensive silicon in it, especially with all that fast solid state storage. Rumors of a $600 machine aren't looking so ridiculous. The pundits are now backing a price of $500, or possibly a little more.

Meanwhile, Microsoft's Xbox Series X could be in for a $400 price. It seems Microsoft may be willing to take a loss to get the sales. Microsoft has the money to take a hit, and now that streaming services give you profits for years afterwards it's not so important to make money on the boxes themselves. Microsoft appears to be waiting for Sony to blink first. Either way we are in line for some seriously powerful consoles. **–CL**

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PC GAMER

Jarred Walton

TECH TALK

Stop With The Mobo Auto-overclocking Shenanigans

RECENTLY, AMD X570 MOTHERBOARD makers came under scrutiny for potentially running the latest Zen 2 CPUs out of spec. This is nothing new, though the methods behind the Zen 2 "cheats" are slightly different. There are various opinions, which distill down to two basic philosophies.

One is that enthusiasts want their PCs to run as fast as possible, and any tuning that a motherboard manufacturer might do in a BIOS is fair game. The other take is that any auto-overclocking or beyond-spec tuning should be disclosed in the settings, and by default a board should run at stock.

With AMD's AM4 X570 boards—and let's be clear, this isn't the first time this has happened, not even for socket AM4—the problem is that some motherboards are reporting an incorrect current (amps) value to the CPU. The CPU uses this value to determine voltage, power, and clock speed, seeking to stay within the specified limits. If the motherboard "lies" and says the current is lower, then the CPU will be able to exceed the normal power limits and potentially run faster.

This technically voids your AMD CPU warranty, just like Precision Boost Overdrive. Whether or not these hacks could cause a CPU to fail is more difficult to nail down. Long term, Zen 2 CPUs built on TSMC's 7nm lithography might be more at risk than 12nm and 14nm chips, but it would still likely take years for most CPUs to fail.

There are some other consequences, however. The biggest is CPU power use, which directly translates into heat. If you're running a four-core or six-core 3rd-gen Ryzen, there's probably nothing to worry about—even eight-core Ryzen 7 3700Xs should be okay. Instead of 65W, your CPU could potentially use as much as 95W, which is well within the limits of what the silicon can handle. No big deal. But with a 105W 3800X, 3900X, or 3950X, power use could be substantially higher. We're talking 160W during "stock" operation, and at least one vendor (ASRock) has some boards that can hit as much as 210W of power draw—all on the CPU.

> This technically voids your AMD CPU warranty, just like Precision Boost Overdrive.

With proper cooling, it's still unlikely to cause any serious issues in the near term. However, some users have noticed substantially higher temperatures on high-end 3rd-gen Ryzen processors, as the Wraith Prism potentially struggles to dissipate 150W of power. Other CPU protections kick in, and "throttling" may occur to keep the CPU below 90 C or whatever, except in this case the throttling is probably just moving the CPU back toward running at official speeds and power. Still, 90 C and higher temperatures are a serious concern, so a user might end up buying a more expensive cooling solution just to keep things running properly—which could mean spending $100 or more to cool a CPU that's running hot because of hidden automatic overclocking.

I've seen test results where on some boards the "stock" performance is higher than what can be achieved with PBO, meaning the motherboard vendors are overclocking via the amperage cheat more than you can get with PBO. Interestingly, enabling PBO appears to disable the erroneous amperage reporting, so vendors were smart enough to know that double-overclocking is a bad idea.

But let me get back to the bigger picture. While AMD boards are the most recent example, they're by no means alone. Intel doesn't even report official all-core turbo clocks any longer, basically letting motherboard vendors run free. There are Z490 boards for the new Comet Lake CPUs that will run the Core i9-10900K at 250W, indefinitely—assuming that your cooling can keep up. Perhaps even worse, I remember testing the first Skylake-X CPUs a few years back, and seeing system power draw during a Cinebench run eclipse 450W with a Core i9-7900X. Even liquid cooling failed to keep up, and I watched power steadily go up until the system eventually crashed!

Frankly, I'm tired of these shenanigans. I understand the desire to make a board appear better than the competition, and I'm not even opposed to auto-overclocking features. Just at least give us a way to run a CPU at fully stock specifications. Because sometimes we actually want to respect the official TDP constraints.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

Nick Peers

OPEN SOURCE

One Boot Disk To Rule Them All

HOW MANY BOOT DISKS do you have lying around your desk? Maybe you have a whole drawer stuffed with burned optical discs or USB flash drives, struggling to remember what bootable medium is on what, or you've tried to make do with two or three drives, swapping ISO images in and out.

Whatever your method, it's a pain keeping tabs on them all. Optical discs are—by their nature—slow to boot and obsolete the moment a newer version of the bootable media in question is released. As flash drive capacities grow ever larger, it seems wasteful storing a single 512MB bootable rescue disk on a 16GB drive. Wouldn't it be great if you could house all your boot disks on a single USB flash drive, then switch between them as required?

Your prayers have been answered. With Ventoy, a new open-source boot tool, you can store multiple boot images on a single flash drive, then choose which one to boot from a start-up menu. It's simple to get up and running: Head to www.ventoy.net and click "Downloads" where you'll find downloadable installers for Windows and Linux.

For Windows, download and extract the zip file's contents, and double-click "Ventoy2Disk.exe." You'll need a single blank USB flash drive—the larger the better. It should be detected automatically (click the "Device" drop-down menu if not). By default, support for secure boot is disabled; switch it on via "Option → Secure Boot Support" if necessary, then click Install to format the drive and set things up.

Then, drag bootable installers in ISO or WIM format onto your flash drive—over 260 are officially supported, but many more should work. Reboot your PC from the USB flash drive to view a list of the copied files. Select one, and it should boot as if you'd created a standalone boot disk for it.

> With Ventoy, an open-source boot tool, you can store multiple boot images on a single flash drive.

Multiple boot media on a single USB flash drive, thanks to Ventoy.

If secure boot is enabled on your PC, you'll need to follow a one-time procedure outlined at www.ventoy.net/en/doc_secure.html—if successful, you're laughing, but I was unable to get the key enrolled on my MSI X470 Gaming Plus mobo when I enabled secure boot. Disabling secure boot meant the drive worked flawlessly.

The benefit of Ventoy is obvious—in my case, I can bring together my various install media (Windows 10, Ubuntu, elementaryOS, and so on) together with a selection of rescue discs, including Macrium Reflect and Lazesoft Recovery Suite, onto a single 16GB flash drive.

When your boot media is updated, download the latest version and either replace the older version with it or run multiple versions side by side for compatibility purposes across your machines. You're only limited by the size of your flash drive.

Ventoy itself is also undergoing rapid development—secure boot was only added in version 1.0.7, for example, while support for persistence across multiple live OSes without having to partition the flash drive arrived in version 1.0.11. The Linux install process is convoluted at the time of writing, but a GUI is already being developed by a third party so don't be surprised to see a GUI option appear for setting up Ventoy on your Linux PCs too.

Adding these to your Ventoy flash drive is simple: Just download the latest version of the installer and use the "Update" button instead of "Install" to preserve current settings and ISO files.

As you delve deeper into Ventoy, the less user-friendly it becomes—persistence is one of several features configured using plugins (unattended installation scripts for Windows and Linux is another). These are basically JSON configuration files stored in a Ventoy subdirectory on your main partition. Thankfully, comprehensive documentation is available to explain how this all works—see https://ventoy.net/en/plugin_entry.html for details.

Nick Peers has been dabbling with Windows, Linux, macOS, Android and iOS since forever.

© VENTOY

THE LIST

EIGHT SERIOUSLY GAUDY PC COMPONENTS

8 COUGAR CONQUER 2

We'll be honest, the Conquer 2 case absolutely terrifies us. It looks like the decapitated head of a particularly nasty Decepticon, and we want it gone.

7 UPHERE CCF150CF

The product description claims this is merely a CPU cooler, but we're more inclined to believe that it's actually some kind of alien hand grenade.

6 ASROCK RADEON RX 5700 XT TAICHI X 8G OC+

This (admittedly pretty good) GPU inexplicably comes with two plain black fans and one completely bedecked with RGB lighting.

5 LIAN LI PC-CK101

Yeah, we've got nothing. It's a little train, with USB ports and space inside for a compact ITX system. It also costs hundreds of dollars. What?

4 TEAM GROUP T-FORCE DELTA MAX RGB SATA SSD

RGB lighting on your SATA SSD, a component that's often tucked away behind the motherboard? Seems pointless, but Team Group did it.

3 DEEPCOOL GAMER STORM CAPTAIN 240PRO V2

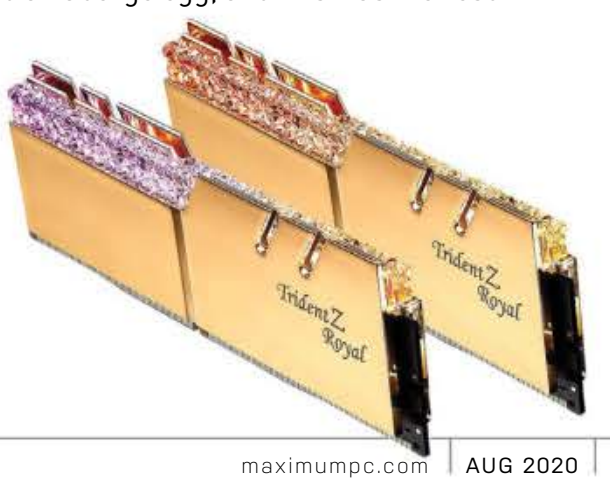
Despite having the most incredible name, this AIO cooler has an ugly cubic pump covered in pointless pieces of light-up plastic.

2 NVIDIA TITAN V

We've all heard about it. Of course, Nvidia had no choice but to cover this monstrously expensive and powerful graphics card with fake gold.

1 G.SKILL TRIDENT Z ROYAL

We love G.Skill, but we never want to see this again. It looks like a stick of RAM made sweet, technological love to a Fabergé egg, and this was the result.



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DOCTOR

THIS MONTH THE DOCTOR TACKLES...

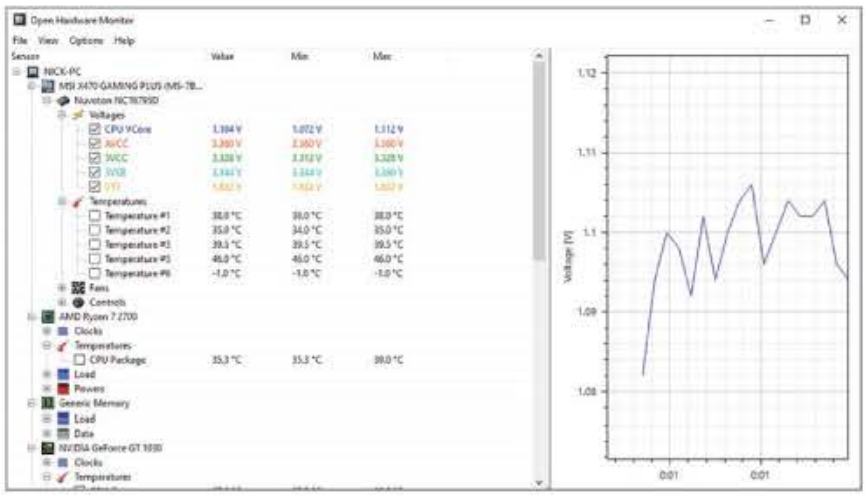
> Random Freezes
> Compatible Batteries
> COD: Warzone Crash

Random Freezes

I have a slim form factor build: AMD Ryzen 2700, 8GB Team T-Force Delta RGB 3,000MHz RAM, a single PNY factory overclocked XLR8 RTX 2060, 250GB Samsung 860 EVO SSD, and 2TB Hitachi hard drive. They're connected to an ASUS ROG STRIX B450-F motherboard, which is stuffed in a Thermaltake Core G3 and connected to a Dell P1914S.

Recently my PC started acting up. Sometimes if I leave it on, the entire thing freezes—mouse, keyboard, and even the power switch become non-responsive. The only solution is to switch the power supply off and on, then reboot. It may be the drivers, but I have an issue installing them—what do I do with the compressed folder that was downloaded? How do I get my other drivers?

I also tried resetting my motherboard settings, but that brings the RAM speed down to 2,400MHz. I've not had any BSODs, nor has WebDiscover invaded my PC, although it got onto my family's devices (all fixed, however). Could it be the temps? **–Rector-Stingray**



Open Hardware Monitor tracks all your PC's sensors.

THE DOCTOR RESPONDS:

The random, unexplained computer freeze is the Doc's worst nightmare when it comes to troubleshooting. Where do we start with this? Let's open with a question about your PSU, which you didn't include in your spec. What wattage is it? Anything 500W or less isn't sufficient to power your PC's spec, so if you've tried to get by with a lower-wattage PSU you should upgrade to 600W as a comfortable minimum, or 750W+ if you can afford the premium that goes with the small form factor PSU your case demands.

Second, could the small size of your case be a factor in random freezes if it's caused by temperature spikes? Use a tool like Open Hardware Monitor (https://openhardwaremonitor.org) to monitor your voltage and temperature over an extended period. Select "Options → Logging" to start recording the figures every second, then after your next freeze, reboot and open the "OpenHardwareMonitor" folder. You'll find a CSV file that you can open in Excel or LibreOffice Calc.

Sudden freezes linked to temperature spikes should be addressed by investigating the interior of your case—check there's adequate ventilation into and out of the case, and around its components by tidying your cables, and ensure that all the fans are spinning when you power up. Check that your CPU heatsink is securely attached and has adequate thermal paste.

If you notice voltage changes—typically in the CPU VCore setting—enable the "High performance" power plan in Windows and it should smooth out. If, however, the voltage continues to fluctuate wildly—particularly just before a freeze—turn your attention back to the PSU and the possibility it may need replacing, even if it offers sufficient power.

Corrupt RAM may also be the cause. Search for "memory" and open Windows Memory Diagnostic. Choose to run the test now or when you next restart your PC, and press F1 when it starts to select the "Extended" test, before pressing F10 and waiting for the tests to complete (this may take several hours). Windows will display the results after rebooting—if there are errors, your RAM will need replacing.

Finally, check that you're running the latest BIOS version for your board (version 3003 as of May 2020) and that your drivers are up to date—use the ASUS Armoury Crate tool (after installation, go to "Settings → Update Center" to see what's available) if you're struggling to update your key drivers.

If the problem continues, try to make a note of what's running on your PC and email the Doc again; remember, the

↘ submit your questions to: doctor@maximumpc.com

more specific information you can provide, the easier it'll be to suggest a practical remedy.

Compatible Batteries

I'm in a pickle. Two years ago, I bought a Realtree Xtra camo-style HP laptop with an Intel Pentium chip. The problem is that my battery is basically dead, and the laptop now only works if I keep it plugged in. I've had major problems tracking down the right battery and bought and returned at least three different ones. What's particularly frustrating is that sourcing batteries for my old HP Pavilion dv7 laptop is much easier—needless to say I'm quite grumpy!

Do you know what battery I need? If so, I would really be grateful. **–Jon Shimamoto**

THE DOCTOR RESPONDS: An exact laptop model number stamped on the underside of the laptop would have gone some way to helping the Doc target a specific battery (as would telling us the batteries you'd already tried). That said, there appears to be only one HP model matching your description, the HP 15-ay070wm. Searching for that plus the word "battery" gives several matches, including this from Reliable Laptop Parts (https://bit.ly/MPCaug-battery) for $39.99.

You don't mention if you've followed HP's own support services, so the Doc recommends you go down that path. Start by visiting https://support.hp.com/us-en/document/c04700771 for some guides and tools to test the health of your current battery. If the tools suggest that the problem isn't with your battery, you might get lucky opening Device Manager, expanding "Batteries" and then uninstalling any ACPI options, before rebooting to allow it to start recharging properly again.

If your battery has definitely reached the end of its life, then the support pages also help you determine what info you need to source a replacement, and provide you with a link to the HP Parts Store—see https://support.hp.com/us-en/document/c00821572 for the info you need if you want to stay on the official path.

Hardware virtualization needs to be enabled in the UEFI/BIOS.

Two Sticks or Four?

Hi Doc, two questions if I may. First, I built a new system mainly for gaming. I chose to populate the board with four 8GB G.SKILL F4-2800C15-8GVR RAM sticks, but after going through the manual discovered the board (ASUS Maximus Hero XI) uses a dual-channel memory architecture. Performance-wise, did I make a mistake filling the four slots—would I have been better off using just two 16GB sticks? Also, would higher spec'd memory provide any performance benefit?

Second, I reused my Corsair H100i AIO from my old system. In this system, either the fans or the pump—can't be sure—pulsates, particularly in performance mode. I've checked the Corsair Link utility while it's pulsating but don't see anything unusual: CPUs are a steady 32 C. Would this indicate something is failing—I bought this cooler in July 2014?

–Steve Vanetti

THE DOCTOR RESPONDS: There's virtually no difference in performance between four sticks of 8GB or two sticks of 16GB, just as there's little difference between running 2666, 3000, or 3200 RAM (outside of Ryzen). The main advantage of choosing two sticks of 16GB is that you'd leave two slots spare for future upgrades, but given you've got 32GB that's not going to be an issue for some time.

As for your second question: Despite its age, we suspect the pulsating is caused by the placement of the cooling pump in your new system and the flow of air around it. Google "Corsair H100i AIO pulsating" and you'll see some videos and forum posts that will provide plenty of potential help and advice to steer you towards isolating the likely cause, and the best way to reconfigure the pump to minimize the problem.

COD: Warzone Crash

Doc: I got a problem. *Call of Duty: Warzone* crashes without any error info. Basically, it closes like I hit exit after 5-10 minutes of play—on any battle or practice mode. I've tried updating everything, even switched back to Windows 10 1903 and went online trying every fix through settings I could find—such as making sure all the shaders are fully downloaded in the game before starting. No dice.

Yet one piece of advice I've found that does work is to sit on the menu screen for 10 minutes before running. Why would that fix things? Seems like the old Nintendo "blow in the cartridge" fix.

–Joshua Giacchino

THE DOCTOR RESPONDS: It looks like a common problem, judging by the comments on one Reddit post (https://bit.ly/MPCaugreddit). Scroll through this to reveal several different workarounds to try. The first one covers some of the steps you've mentioned following, but others involve creating a special BAT file to launch the game with, renaming "ModernWarfare.exe" as "ModernWarefare.exe1" each time, and removing the player folder in your documents, running a series of commands (make this a BAT script to save time), restarting your PC, and then renaming the program executables.

Long story short? The game is bugged to hell, and until the devs get a fix on the problem you've two choices: Accept the 10-minute wait before playing each time, or find a more stable alternative.

Can't Enable Sandbox

In the May 2020 issue one of your articles mentions using Sandbox. I would like to use that feature, but cannot access it from Windows Features, as the option is greyed out. When I put the cursor over it, it read "Sandbox cannot be installed: virtualization support is disabled in the Firmware." When I went into my ASUS Prime A270-A motherboard's BIOS, I found nothing there that would apply to Sandbox. What am I missing? My processor is an Intel i7-7700K, so it should be compatible. **–Ken Payne**

THE DOCTOR RESPONDS: You're looking for the hardware virtualization feature, which is usually buried deep inside the BIOS/UEFI settings. In your specific case, you need to navigate to "Advanced → CPU Configuration," where you'll find the "Intel Virtualization Technology" setting—switch this to "Enabled," save your changes, and you should be able to make use of Sandbox.

Other BIOSes may bury the settings deeper still using even more obscure terminology; taking the Doc's X470 Gaming Plus mobo as an example, you need to navigate to "Overclocking → CPU Features" and enable the "SVM Mode" setting. If all else fails, your mobo manual should provide a route to the setting, or keep an eye out for terms like "VT-x (Intel)," "AMD-V," or even "Vanderpool."

A quick note: It also requires Windows 10 Pro.

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THE FLAGSHIP

COMET LAKE PC

We look at what you can achieve with Intel's latest processors in the world of gaming and rendering

COMET LAKE hath cometh, and with it Intel has brought a bevy of new features into the headlines of its latest processors. That means a new socket, a new chipset, more cores (more heat), and of course, more performance.

But is it quite enough to compete with the juggernaut that AMD has become? We already know that 3rd-gen Ryzen represents incredible multi-threaded power at a comfortable price. But the one area those zenified processors don't quite match up is typically in the gaming department. On the whole AMD's IPC (instructions per clock cycle), although much improved on Ryzen's debut, still aren't up to Intel's level.

The big question, then, is whether Intel's IPC advantages in its flagship 10-core processor give it the edge over the AMD Ryzen 9 3900X in both gaming and rendering, and if so, by how much? And is that enough to warrant the extra $100 in price? That's what we're looking to find out.

But before you dive into your email inbox, ready to lambast us for once again featuring a crazy, over-the-top gaming PC on the front cover, you might want to take a quick glance over at page 60. There you'll find Christian's take on a fantastically quiet audio recording workstation, ideal for any and all after inspiration on how to throw themselves into the world of benignly silent computing.

Yep, we've heard your concerns, and we feel them too. This edition of *Maximum PC* we're running two separate builds, with in-depth coverage across both, and every issue going forward we're aiming to produce two systems that are the antithesis of one another whenever we can.

Now that's out of the way, let's see what we included in this wee beastie of ours, and why. **–ZAK STOREY**

INGREDIENTS

PART		PRICE
CPU	Intel Core i9-10900K	$530
GPU	Zotac Gaming GeForce RTX 2080 Super AMP Extreme	$780
Mobo	Gigabyte Z490 Aorus Pro AX	$270
Memory	32GB (4x8GB) Corsair Dominator Platinum RGB White @ 3600 MHz	$335
SSD 1	1TB Corsair Force MP510 M.2 PCIe 3.0 SSD	$268
SSD 2	2TB WD-Black SN750 M.2 PCIe 3.0 SSD	$360
Cooling	EKWB EK-AIO 360 D-RGB	$167
PSU	750W Corsair HX750i 80+ Platinum	$205
Case	Corsair iCUE 465X Mid Tower	$140
Total		**$3,055**

PRICES CORRECT AT TIME OF PRINTING.

THE HARDWARE

INTEL CORE I9-10900K $530

THE CREM DE LA CREM of Intel's arsenal, the Intel Core i9-10900K is the kingpin at the top of Team Blue's latest processor pile. Complete with 10 cores, 20 threads, 20MB of smart cache, and a 5.3GHz max turbo speed across two cores, it's Intel's fastest mainstream processor to date.

It's certainly not flawless, however. With those 10 cores comes an incredible amount of both heat and power draw. 14nm++ isn't the best manufacturing process to leverage this design on, and because of that, even at stock with a triple rad/360mm AIO, you're looking at temps well up into the 80 C range. On top of that, power draw can often be above 200W under load. These are all things Intel's tiptoed around with some fantastic pin-point precision engineering. Whether that's a thinner, larger silicon die or over-engineered VRMs and MOSFETs on the motherboard, the Core i9-10900K is a guaranteed titan of a flagship, as long as you can keep it cool and fed.

ZOTAC GAMING GEFORCE RTX 2080 SUPER AMP EXTREME $780

NEXT UP on the chopping block for our no-holds-barred Comet Lake PC is the graphics card. This time around we've gone with Zotac's incredibly beefy RTX 2080 Super AMP Extreme edition. Currently unavailable due to high demand, it packs in some incredible performance at 1440p and 4K, and this model even clocks higher than its big graphical brother the RTX 2080 Ti. On top of that, you get one heck of a cooler. No seriously, it's massive: This is by far the biggest graphics card we've ever seen, measuring in at 12.8 x 5.4 x 2.3 inches across its massive 2.5-inch PCIe slot bulk.

MEMORY

32GB (4X8GB) CORSAIR DOMINATOR PLATINUM RGB WHITE @ 3600 MHZ $335

OKAY, WITH this build we're actually not aiming to hit a specific price point here. In fact what we're secretly trying to do is use this as an opportunity to pit Intel's Core i9-10900K 10-core processor against AMD's Ryzen 9 3900X in a fair fight. That 3900X currently lives inside of our December issue's liquid-cooled build, complete with 32GB of G.Skill Trident Z RGB DDR4 @ 3600, and features twin EVGA RTX 2080 Super XC Ultras (a quick SLI disable will solve there being two of those).

Now because of that we needed some high-spec memory to match our Ryzen build. When Corsair offered us its latest unreleased Dominator Platinum RGB White kit at 3600 MHz, we knew we had to pull the trigger. It's not a cost-effective solution, and Intel's architecture doesn't particularly benefit from the higher speeds, but it will ensure it's a fair contest when it comes to video rendering.

MOTHERBOARD

GIGABYTE Z490 AORUS PRO AX $270

FOR OUR MOBO we've gone with Gigabyte's Z490 Aorus Pro AX ATX board. It's a well-rounded and almost affordable mid-range motherboard, perfect to house our Intel Core i9-10900K. It comes with memory support for up to 128GB of DDR4 @ 5000MHz, features 2x M.2 PCIe 3.0 connectors, and also bundles in Wi-Fi 6, and an Intel 2.5Gb/s lan port too.

As well as featuring a handy amount of connectivity, it actually looks good. Gigabyte has come a long way from its early Aorus days, and the subtle branding, lightweight fonts, black brushed aluminum, and dare-we-say-it tasteful RGB choices make this a real contender for those looking to build a Comet Lake system.

STORAGE

1TB CORSAIR FORCE MP510 M.2 PCIE 3.0 SSD, 2TB WD-BLACK SN750 M.2 PCIE 3.0 SSD $628

ONE AREA where we couldn't quite keep up with AMD for this build was storage. This is one of the bigger caveats of running Intel right now. We still don't have access to PCIe 4.0, despite the fact that we have a new socket, and the chipset (and some motherboards) have it already onboard for future-proofing.

To that end, we've gone with two hefty drives to back up that performance loss. For our primary OS drive, we've opted for a 960GB Corsair Force MP510, and for our secondary drive we've gone with the equally impressive WD Black SN750 in a 2TB capacity. Despite being perhaps considered a lower quality drive, the MP510 packs in random 4K figures much higher than that of the SN750. Ultimately, however, both of these drives will provide us with some nippy performance for transferring those hefty files around when working with video content. Once the content's produced, in a system like this you could theoretically hold it on the 2TB SN750 until it's been used or uploaded, and then move it onto a home NAS.

COOLING

EKWB EK-AIO 360 D-RGB $167

TO COOL our mighty setup, we've opted for EKWB's EK-AIO 360 D-RGB. We're starting to see a lot of triple-fan 360mm AIO designs pop up out there, but this is one of our favorites, as it's so different from what we've seen from other manufacturers. The CPU block features a clean frosted-acrylic design, the included fans are the older style RGB Vardars, and it's just a nice piece of kit to have in your build. It is a touch on the pricey side, but it features compatibility with every motherboard manufacturer out there, comes with a five-year warranty, and is impressively simple to install, although more on that later.

POWER SUPPLY

750W CORSAIR HX750I 80+ PLATINUM $205

OUR POWER SUPPLY for this build is actually one we're going to be using for our case review-testing going forward: The Corsair HX750i 80+ Platinum. This fully modular PSU features a zero-noise fan curve, alongside a stonkingly good efficiency and full modularity. We've also coupled it with a set of Corsair's Pro series black sleeved cables to give everything a bit more of a premium feel.

Under load we're expecting this system to pull anywhere between 500-600W from the wall, so hitting that 75 percent load on the power supply should give us close to perfect overall efficiency, both in terms of heat and wasted energy.

CASE

CORSAIR ICUE 465X MID TOWER $140

WHEN IT CAME to the case we knew we wanted to take a look at Corsair's latest iCUE 465X RGB, but it comes with a slight hiccough. All in all it's a fantastic chassis for the build, especially with a few tweaks to the intake airflow (although more on that later), but the big problem we have is the price, combined with those front fans. Because we're using the EK-AIO for our build, we'll need to install the 360mm radiator in the front. That works out fine, but the iCUE 465X's party piece is the three included LL120 RGB fans, hooked up to an internal RGB controller.

In our system we ended up removing these and not using them. However, this was more of an aesthetic decision than an outright logical thermal one. The thing with that is we're then spending cash on three fans we're not actually going to use, and sadly Corsair doesn't offer a variant of the 465X sans colorful fans, which is annoying.

BUILDING THE COMET LAKE CHAMPION

DELVING INTO THE MURKY WORLDS OF RGB, GAMING, AND RENDERING GLORY

LENGTH OF TIME: **1–2 HOURS** LEVEL OF DIFFICULTY: **EASY**

1 UNBOX THAT CASE

SO HERE'S OUR FIRST LOOK at the Corsair iCUE 465X RGB, with the side panel off. It's not a bad layout at all—it's nice to finally see Corsair fully embrace the full-length PSU cover, as opposed to what the company had been doing with the three-quarter length adjustable plastic—and there's some seriously good ventilation for that front panel as well.

What's up for debate? Well that front fan filter for one thing. The cross-pattern lining is just a bit ugly and boring in our eyes, and as dust filters like this typically hinder airflow significantly, the first thing we'll be doing is removing it.

4 DDR4 INSTALLATION

HERE WE'VE GOT our first look at Corsair's white Dominator Platinum RGB DDR4. This special-edition memory looks killer, and those high frequencies should ensure we have a fair playing field with our comparative build. Although the CPU architecture doesn't benefit in the same way as Ryzen does with higher frequencies, in video-editing tasks the faster your memory is the more bandwidth you have, and the quicker you can render those video files.

To install, lift up the tabs at each end of the DDR4 slots on the motherboard, and carefully slot the sticks into position, making note of the offset notch on each RAM stick and the DIMM slot. If using fewer than four sticks of memory, refer to your motherboard manual as to which slots you need to install your memory into.

2 TEAR DOWN

THE FIRST THING on the list is to remove as many panels as we can. The front tempered-glass panel comes off easily enough; undo the four lengthy thumbscrews (one in each corner), then the entire front section can be pulled away from the case itself. Easy as pie. We'll also remove the three front intake fans here as well, being careful to unclip them from the RGB controller in the back of the case, and remove the dust filters all round.

One thing we're not doing at this stage is removing that bottom-most hard drive cage. In hindsight we should've done that, but more on that later.

3 INTEL'S LGA1200 SOCKET

INTEL'S LATEST 10th-gen processors feature a new socket. LGA 1200 increases the size of the overall socket and the CPU itself. This has been done primarily to give Intel room to spread the CPU die out further, effectively using a thinner, wider die to dissipate more heat across a larger surface area, which in turn has allowed Intel to increase core count and clock speed without running into thermal bottlenecks so often. The cooler mounting points are in the same position as they were before, so any old AIOs or fan towers you're using should fit fine.

The installation process is also much the same as it's always been; lift the retention arm, identify the gold triangle on the CPU (bottom-left corner), gently place the processor in, resecure the bracket, and pop the retention arm back into place. The plastic cover will then pop off.

5 M.2 STORAGE INSTALL

IF YOU CAN AFFORD IT and have support for it, we'd recommend you opt for M.2 storage over everything else outside of backup hard drives (even then, you're probably better off going with a local NAS storage solution). The reason being is they remove cables and clutter, improve airflow in your chassis, and can be hidden out of sight.

We're hiding these drives under the Gigabyte Aorus Pro AX's massive M.2 heatsinks located between those three PCIe slots. To install, remove the heatsinks, carefully remove the 2280 M.2 screws, note the notch on the M.2 socket and your M.2 drive, slide them into position, and resecure them down using the M.2 screws. Then reinstall the motherboard heatsink, making sure to remove any plastic film on the thermal pads first.

6 MOTHERBOARD IN

NOW THAT WE'VE GOT our motherboard prepped, it's time for it to go in the chassis. One thing we forgot to mention earlier (darn word counts getting in the way) is that we've also pre-installed the EK-AIO's mounting backplate to the board itself. It's simply a case of identifying the four long thumb screws you need for your socket, lining up the included backplate, and installing it by hand.

To install the motherboard, carefully place it in the case—it's best to have the system laying flat on a table when you do this—line it up with the motherboard stand-offs, then secure it using the included screws found in the case accessories box located in the hard drive caddy.

7 360MM AIO COOLER PREP

AT THIS POINT we're going ahead and prepping the cooler itself. The EK-AIO comes as standard with pre-applied thermal paste, but as we're not a fan we're wiping it off with a Noctua thermal paste cleaning wipe (isopropyl alcohol will also do the trick), and installing the Intel LGA bracket.

It's a simple process; find the two brackets included in the cooler box, and the four screws. Slot them into position, making sure the folded edges are facing downwards, and secure them with the four Phillips screws. If we were mounting this in a pull configuration, with the fans on the inside, we'd install the EK Vardar 120mm fans now too, using the longer screws designed for the radiator. However, for this build, we're going to use the fans as a pushing intake, situated at the front of the case, so we can leave this until the next step.

8 FAN INSTALLATION

NOW THE COOLER'S all prepped and the mounting mechanism ready on the motherboard, it's time to mount the radiator and the fans to the case. Carefully slide your radiator into the front of the chassis, then place a 120mm fan in the bottom segment, making sure you orient it so that the cables are facing toward the rear of the chassis. Once in, pre-thread those same cables through into the back of the case for cable management later on. Then, use the included long-threaded screws to go through the fan-mounting locations and into the radiator screw threads.

Only install two per fan, in a diagonal pattern, and don't secure them all the way down until all three fans are in. This gives some slack to fit the last two fans, without there being too much tension. Once all three fans are in, tighten the screws, and install the remaining ones.

11 FRONT-PANEL HEADERS AND FANS

AS THIS BUILD is going to be fairly intense when it comes to lighting we're not going to worry too much about installing any other front-panel header cables other than the power switch itself. Everything else, aside from USB and audio connectors, is superfluous.

On top of that, we've decided to connect all three of the front intake fans into the headers on the bottom of the board here. The EK cooler does come with a three-way to one-way connector, but we're big fans (ha!) of having control over each individual fan in our build; that way, if need be, we can dump more cool air directly onto our GPU, and then run the top two fans quieter if we so desire.

12 THE MONSTER GPU

CAN WE APPRECIATE how massive this graphics card is? It's ridiculously big, and comes with a serious triple-fan cooler and twin 8-pin PCIe power connectors. It makes its competitor GPU situated in the comparison build—the EVGA RTX 2080 Super XC Ultra Gaming—look puny.

The big downside? That GPU sag. It's real, and it doesn't look that great. You can buy support bars to install underneath a card like this, but we find that it detracts from the overall look. Alternatively, some Phanteks cases come with a rear-sided motherboard bracket that helps to reduce GPU sag as well. Either way, it shouldn't cause any major problems, but it does look unsightly.

9 THERMAL PASTE APPLICATION

OH BOY, where to begin with this one? The amount of thermal paste you use isn't that important, as long as you're using the bare minimum. What's the bare minimum? For an Intel LGA1200 processor, a pea-sized dot will do; for Ryzen, you might want to bump that up a bit. Alternatively, using more isn't necessarily a bad thing, unless your paste is conductive, at which point if you get it on the processor's PCB or the motherboard itself you could end up with a shorted processor.

Pro overclockers often dump an entire tube of thermal paste on top of processors when they're competing at events, but the best advice for the average person is to aim for that lower amount and you're good. The pressure from the CPU block itself (especially on these smaller chips), will spread out the paste and ensure you have good contact across the entirety of the block.

10 CPU BLOCK INSTALLATION

IT'S NOW TIME to install the block. Carefully place your block on top of the CPU, then use the included thumb screws to secure it. Do this in a diagonal pattern—install the bottom-left thumb screw, then the top right, then bottom right, then top left, tightening each a little bit at a time until you reach the end of the thread. This ensures you're not putting too much pressure on one side of the processor during the install, makes it easier to install the thumb screws, and doing it by hand means you won't overtighten and potentially damage the processor's PCB. Once that's done, plug the pump's fan header into the motherboard, and with the EK unit, its D-RGB header too.

Our EK block looks really clean unlit like this. The tubing is a bit tight, but we've been told this is due to the fact EK reinforces its tubing with a protective internal sleeve to prevent against long-term wear and tear.

13 POWER SUPPLY WOES

NOW TO TACKLE the power supply and cabling. The Corsair iCUE 465X is what you'd expect for a mid-range tower—short and sweet, in length anyway. It's designed for mid-range products, including power supplies, so it's difficult to fit our full-length PSU in (it's around 7.08 inches in length), especially with the cables pre-installed.

You could easily install it without the cables attached, and then try to install them afterwards, but since we're not using the hard drive caddy at all in this build, we thought heck, let's just remove it. To do that you need to turn the case on its side and remove the four Phillips screws from the base, and one attached to the back of the motherboard tray, then slide the hard drive cage along to the back where the power supply will be situated, and pull it out. Then just install your power supply, sorting out the remaining cabling situation, and you're good to go.

14 ALL WRAPPED UP

WE DIDN'T HAVE a chance to configure all of the RGB in this build before taking the final shots (photography time is limited in this era of lockdowns), so some of the components are set to rainbow mode, and some are connected directly to the Gigabyte motherboard (namely the EK cooling), which defaults to orange, but it looks darn cool.

You'll note we've omitted that front fan filter. This does two things: Firstly, it means we are inevitably going to have to dust the interior of the case a bit more often than before, but more importantly it improves airflow significantly compared to running the chassis with it in place (we've got a feature coming up on that soon). Also, it removes that gaudy criss-cross pattern from the front of the 465X.

THE NEW RENDERING KING?

AND THERE you have it folks, one crisp, clean, overly expensive, armored-to-the-hilt Intel Comet Lake build, complete with 3TB of storage, 32GB of DDR4 @ 3600MHz, and 10 of Intel's finest 14nm++ cores. On the whole the build experience was very enjoyable; working in the Corsair iCUE 465X, despite first impressions, was a smooth ride with no major complications. Even afterwards, when we had to do a bit of troubleshooting to diagnose some suspect memory problems (reseat the CPU, it's always reseat the CPU), the case provided us with no issues whatsoever. And with that front criss-cross fan filter out of the way, this thing just looks killer. Corsair, if you're reading this, you need to pump one of these out in an ITX form factor for sure—240mm AIO support in the front, 2 x 120mm fans in the roof, and a vertical GPU mount would be a kick-ass case. For a mid-tower though? It ain't half bad either.

BENCHMARK CHANGES

Okay enough, let's get down to the brass tacks here. The big question we want to know is whether Intel's latest Comet Lake flagship can keep up with AMD's Ryzen 9 3900X. It's a tough competition. On the one hand, you have our Ryzen competitor with 12 cores, 24 threads, a whopping 68MB of cache, and a fairly solid 4.6GHz max turbo speed (or 4.2-4.3GHz across all cores), combined with a fairly decent stock cooler, available at just $420. On the other side, Intel's Core i9-10900K comes with 10 cores, 20 threads, 20MB of "Smart Cache," and a phenomenally impressive 5.3GHz max clock speed (which again is around 5.0-5.1GHz across all cores), all for $530. You don't get a cooler with it—but to be fair, even if you did, if you were to buy either of these chips, we would wholeheartedly recommend that you pick up an after-market cooler anyway. So ultimately then, Intel is down on thread count and cache, but higher on the pure grunt that is single-core IPC and clock speed.

We should explain our testing methodology here too. Our comparative system, outside of storage, is very similar. It's actually the 4K Gaming Monster we did last year, but with different memory and one of the RTX 2080 Supers disabled in all of our benchmark tests. Yes, it's liquid cooled, allowing GPU boost and AMD's PBO to work their magic, but on the other hand the GPU follows a basic PCB power design and has lower advertised clock speeds than our Zotac RTX 2080 Super in this build.

On top of that, we're also bringing in a few additional CPU tests to give you a better idea of which platform performs best. There is, of course, more synthetic tests courtesy of Cinebench, TechARP x264, and Fry Render, and additionally we've added two real-world tests, thanks to Adobe. Yep, we'll be putting both processors through their paces by getting each system to render a bespoke five-minute 4K video in Adobe's Premiere Pro CC, using the H.264 codec and the YouTube 4K preset. On top of that we've also put together a short-but-sweet Adobe After Effects video intro, which again we are going to get both machines to export in 4K, but this time under the AVI file format.

THE RESULTS

Boy did we get some interesting figures from this. Straight out of the gate in our synthetic tests the AMD comparison system hammered Intel in Cinebench R15's multi-core tests, and we've got to admit, at 192 points, its single-core performance was impressive as well, albeit still not a patch on the Core i9's 225. It also beat the Core i9-10900K in TechARP's x264 benchmark, too. However, this is where things get interesting: In Fry Render Intel won the competition by a single second. That doesn't sound like much, but this is a rendering test, and Intel is down by four threads.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Single (Index)	192	225 (17%)
Cinebench R15 Multi (Index)	2,952	2,590 (-12%)
TechARP x264 (fps)	61.08	56.20 (-8%)
Fry Render (m:s)	1:17	1:16 (1%)
AIDA64 Memory Bandwidth (MB/s)	55,051	51,195 (-7%)
AIDA64 Memory Latency (ns)	71.4	50.5 (29%)
SSD 1: CrystalDisk QD8 Sequential Read (MB/s)	4,992	3,352 (-33%)
SSD 1: CrystalDisk QD8 Sequential Write (MB/s)	4,284	2,961 (-31%)
SSD 1: CrystalDisk QD1 Random 4K Read (MB/s)	60	54 (-10%)
SSD 1: CrystalDisk QD1 Random 4K Write (MB/s)	220	177 (-20%)
Adobe Premiere Pro 5-Minute 4K Render (m:s)	1:19	1:28 (-11%)
Adobe After Effects 10-Second 4K Render (m:s)	6:14	6:13 (0%)
Total War: Warhammer II (fps)	54	65 (20%)
3D Mark: Firestrike (Index)	21,453	23,159 (8%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero point consists of an AMD Ryzen 9 3900X, 32GB (4x8GB) G.Skill Trident Z RGB Neo @ 3600, an EVGA GeForce RTX 2080 Super XC Ultra, and a 1TB Corsair Force MP600 M.2 PCIe 4.0 SSD. All game tests were performed at 3440x1440 on Ultra.

1 **EK's really nailed it with the styling on this CPU block. The EK-AIO looks incredible, with or without lighting.**

2 **There's no doubt that this graphics card needs a support bracket or something to help keep it up, if only for our soul.**

3 **Corsair's latest Dominator Platinum RGB white edition memory looks utterly sublime, although we do wish it'd go back to the single-light top strip.**

4 **If you can, remove dust filters from the front of your intake fans. It might increase the number of PC cleans you need to do, but your thermals will thank you.**

Moving on to the memory tests, and things fall where we'd expect them to. Latency-wise, Intel always edges out AMD, quite substantially. In part we believe this is down to the fact that AMD's core complexes (each one housing four cores) have to communicate with each other and the memory when processing requests, and because of that there's a small delay added on to the latency. It's an architectural difference that's difficult to get past. With Intel and its monolithic design, latency remains consistently lower, and has done since the days of Skylake. Interestingly, despite both platforms supporting dual-channel DDR4, and both systems using 3,600MHz kits with a C18 latency, the Intel system falls behind in pure memory bandwidth, coming in almost 4,000MB/s lower than its AMD rival. We can only put this down to early teething issues with the motherboard BIOSes themselves, as the results should be very similar.

And now we get to the real-world tests, and this is where things really get shaken up a bit. Let's keep this brief. 4K Premiere Pro video export? AMD, nine seconds faster. 4K After Effects video render? Intel, one second faster. It's genuinely impressive. Despite the extra cores, the extra cache, the synthetic tests showing that AMD had the advantage when it came to memory bandwidth, Intel's single core (and likely Adobe optimization) managed to narrow the gap significantly. It's nothing short of awesome, especially when that processor is effectively four threads down on a fight like that.

WRAP-UP

So in conclusion, it's a tough one to call. In real-world scenarios, the two processors are neck and neck. Seeing them that close to one another despite the differences is just remarkable, especially given how long Intel's been on that 14nm manufacturing process. However, it's still hard to deny just how much AMD has the advantage in terms of cost to performance. For most of those challenges, it was still either on par or beating a CPU from the competition that costs $110 more than it does. And on top of that, it supports PCIe 4.0 storage as well, on a very mature platform. And as you can see from those results, the differences as far as storage goes are staggering. If you're moving big files around on a day-to-day basis—which let's face it, is very common with video-editing—AMD's offering is still by far the better value choice.

That said, you have to admire Intel for what it's managed to achieve with this. A lot of engineering work has gone into making sure that its 10th generation is still competitive, despite the fact it's based on a five-year-old architecture and a six-year-old manufacturing process.

It's a tough one to call. For those of you who are very much rooting for Intel, if you do need a fast processor for work like this, you're not going to be disappointed picking one of these up (if you can find them in stock), but you've got to know that that comes with an extra $110 cost at a minimum, and you lose out on the storage. Yeah, you gain in gaming, but that's not for everyone. The smart choice is AMD, for sure, every time, but there's no denying that the Core i9-10900K is still one kick-ass chip.

LICENSE TO FAiL

Join **Christian Guyton** for a walk down memory lane as we recall the 20 biggest computer industry flops of the last 20 years

THE CONSUMER TECHNOLOGY field is, without a doubt, an absolute hotbed of technological innovation. Over the last few decades, we've seen computing make incredible strides in processing power, graphical capability, and data storage. There have been inspired new moves, like the introduction of simultaneous multi-threading and hyper-threading to double the available threads of CPUs, as well as improvements to software, hardware, and network infrastructure that have made things like 4K video streaming a reality. It wouldn't be an overly bold claim to say that the PC hardware industry and community are in the best place they've ever been (any global pandemics notwithstanding, of course).

However, it hasn't always been happy faces and full coffers in the computing industry. There have been mistakes, bad judgements, humiliating missteps: Some tragic, some hilarious. It's not uncommon for a brand to release a product or service they firmly believe is going to be the Next Big Thing, then throw all of their marketing resources behind it only for it to fall flat on its face, selling like a Boyz II Men Christmas album in early April.

The past two decades have brought us some incredible innovations, but plenty of flops as well—and they are what we're going to focus on today, in pursuit of comedy and perhaps a few cautionary tales.

20

Windows Millennium Edition

It seems fitting to start with Microsoft's turn-of-the-century blunder, Windows Me. That's "Millennium Edition", in theory. In practice, it was dubbed the "Mistake Edition," with a cavalcade of issues plaguing it after release. Sometimes it would refuse to function with existing software; sometimes it would refuse to start up at all. Microsoft scrambled to fix the stability issues and numerous glitches, releasing patch after patch, but the damage was done, and Windows Me was immortalized as one of the worst operating systems ever to be released.

19

Seagate Barracuda 7200.14

There was an awful lot of drama around this one. In 2008/2009, customers around the globe reported drive failures and data loss using Seagate's 7200.11 hard drives. The issue was identified as a firmware problem, and led to a demonstrably higher rate of failure in the 7200.14 and other drives in the family. Seagate did release a firmware update and offered free data recovery services for affected drives, but the damage was done. The manufacturer was also accused of censoring posts on its forums that discussed the failing drives, leaving many customers angry.

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18
OQO

It's a tiny Windows system! The first OQO device, the Model 01, actually had a lot going for it, including Bluetooth connectivity and a Wacom-designed stylus, but sadly the technology just wasn't there yet. The five-inch LCD display was too small to properly encapsulate the excellence of Windows XP (still, to this writer's mind, the greatest OS of all time), and the initial OQO handheld was released before Microsoft finalized the Tablet PC Edition of XP. Attempting to run XP Professional on this tiny tablet was, by all accounts, hellish. OQO soldiered on to release four more models, but sadly declared bankruptcy in 2009.

17
Google Glass

Glass was a cool piece of tech, but the world wasn't ready for augmented reality glasses in 2013. Wearable tech is swiftly finding more of a purchase in our society, so we wouldn't be surprised to see a triumphant return for Glass in a few years' time—Google is already marketing a reworked version to enterprises. The original Glass, though, was branded by many as a privacy-invading badge of purported intellectual and financial superiority, and it was wound down after nine months.

16
HP TouchPad

HP's modern Windows tablets and convertibles are top-notch hardware (we adore the sleek and silent Spectre x360 2-in-1), but the computing giant was late to the party. The TouchPad was supposed to be HP's answer to Apple's wildly successful iPad, but the late Steve Jobs held a killer keynote not long before the TouchPad's release, announcing the iPad 2. The products released within the same window, and the world was busy fawning over Apple's latest gem, so the TouchPad sunk into obscurity with alarming speed. The wonky OS didn't do it any favors, either.

15
Facebook Portal

Little more than a glorified monitor for easier video calling, the Facebook Portal released in 2018 to minimal fanfare. With allegations of data theft and privacy invasion being thrown in every direction, consumers were—perhaps unsurprisingly—reluctant to spend hundreds of their own hard-earned dollars to install a Facebook-controlled camera and microphone in their homes. Critics also tore the product to pieces, and some fairly murky language from Facebook surrounding the data-gathering functions of the Portal didn't help matters. Although the social media titan has since launched a 2nd generation of the product, the low sales of the original Portal mark it as something of a misstep for Facebook.

14
Google Nexus Q

Another early effort to cash in on the home media streaming boom, the Nexus Q was a weird little orb that could stream content from YouTube, Google Play, and... no, that was everything. The limited content library, high asking price, and clunky user interface meant that the Nexus Q was never destined for greatness. The killing blow was undoubtedly the fact that speakers were not included by default. The product never even made it to a full release; the public launch was indefinitely postponed while production wound down in favor of the Chromecast, and some early adopters were even given the product for free, albeit without ongoing Google support.

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13

Microsoft Surface RT (& Windows RT)

The Surface RT brought us the worst of both worlds: A mediocre tablet with a massive bezel and a broken, confusing OS. Windows 8 was already in dire straits with low adoption figures, but the version that Microsoft adapted for the lightweight new tablet's 32-bit ARM-based processor was an utter mess. Software compatibility was poor from the outset, and the OS frequently ran slowly or failed to launch Windows Store apps. The tablet itself was fine but unimpressive next to the other Surface models. It was a massive commercial failure for Microsoft, costing the company somewhere in the region of $1 billion as unsold tablets were discarded en masse.

12

Google Fiber

Okay, so this one actually did enjoy some limited success, although things didn't really go according to Google's plan. It managed to get the ball rolling, but progress was slow and costly, with proper fiber broadband and phone services ultimately only reaching nine locations across the entire country. Google burned through billions of dollars digging up roads and installing fiber-optic cabling, but saw less than half a million customers in 2016, even after five years of work. Google hasn't given up yet—just last year, the corporation laid 600 miles of fiber-optic cables in San Antonio, Texas—but the corporation has also had to pull out of Louisville, Kentucky, amid claims of poor workmanship.

11

Radeon R9 285 2GB

This model of AMD's successful Radeon R9 series of GPUs wasn't really a bad product, it was just a victim of bad timing and sub-par marketing. Released shortly after the R9 280, the 285 only offered modest performance improvements of a few percent against its predecessor, along with an unimpressive 2GB of VRAM and DirectX12 support that wasn't widely used at the time. It mostly just served to clog up the market, as the R9 280 was already a decent GPU. A price drop followed almost immediately after release, as Nvidia released the superior GeForce GTX 970, further diminishing the R9 285's legitimacy. Ultimately, this card had little impact and faded into obscurity.

10

Windows 8

It was bad, wasn't it? This might be the item on this list that is freshest in most people's memories, especially given that it is still widely used. The goal was to create a "best of both worlds" OS, ideal both for desktop PCs and tablets, where Microsoft's Surface line was in hot competition with iOS. Unfortunately, Windows 8 proved slow on portable devices and clunky on desktops, with a fiddly Start screen formed of numerous tiles of varying sizes. A metric tonne of preloaded bloatware was the final nail in the coffin. Windows Vista might have been the subject of many IT department jokes for years, but Windows 8 was not such a laughing matter: It simply wasn't good.

09

Nvidia GeForce GT 1030 DDR4

The original GDDR5 version of Nvidia's GT 1030 was a perfectly serviceable low-end gaming GPU, ideal for 720p and sometimes 1080p in less-demanding games. It was also modestly popular for cryptocurrency-mining rigs, and sales were strong thanks to a sensible asking price of around 70 bucks. The problems arrived when Nvidia quietly released a new model with DDR4 memory transplanted in. Despite having about a third of the original's memory speed, it wasn't much cheaper, and many uninformed buyers ended up with a crap card that often failed to hit even 30fps at 1080p. The only real advantage was the somewhat lower TDP, and since some third-party manufacturers were unclear about which memory type their cards used, buying a GT 1030 became a very risky endeavor. A rather embarrassing boo-boo for Nvidia.

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08 Google Daydream

Oh Google, we're surprised to see you appear so many times on this list! Hang on, let us check our notes... no, actually, we're not surprised at all. Google's ill-fated foray into virtual reality was barely able to trade blows with its main competitor, Samsung's Gear VR, since it launched too late to make an impact. Smartphone-based VR was already struggling in the face of the more powerful PC-tethered Oculus Rift and HTC VIVE headsets, and we now have fully wireless all-in-one models like the Oculus Quest, which incorporate a compact gaming system inside the VR headset itself.

The other main issue that hamstrung Daydream was a lack of variety in its software library. Despite being touted as a great new platform for Android VR, many phone manufacturers and developers took no steps to accommodate or support it.

07 Apple "Butterfly Keyboard"

It wouldn't be *Maximum PC* without a cheap snipe at MacBooks, right? The butterfly keys are an example of Apple refusing to admit when it got it wrong. The design (first introduced in the 2015 MacBook) allowed for a thinner laptop thanks to a flat key switch that was hinged in the middle, instead of two hinges on either side that crossed in the center. This made it more vulnerable to small debris getting trapped under the keycap and preventing the key from functioning. Defunct keys, sticking, and unintentional double-pressing were common problems, but Apple was quick to deny that the butterfly keys were the problem. Repairs from Apple itself were costly, as often the entire keyboard would need replacing. Multiple iterations of the butterfly key attempted to fix the issues, but were only met with moderate success. Last year, Apple released a new MacBook Pro, and the butterfly keyboard was conspicuous in its absence.

06 Skype

How do you blow such a hefty lead? Skype rocked up early to the video-calling arena, launching way back in 2003 and cornering a major chunk of the market, mostly due to lack of competition. The app was so successful at first that its name became unanimous with video-calling as a whole: To "Skype" someone often just meant to video call them, regardless of platform.

Of course, success in the tech industry always draws in the big fish, and Microsoft snapped up Skype in 2011 for almost $9 billion. At the time, the service had over half a billion users worldwide, but it's been downhill since. The coronavirus pandemic has seen an uptick in use, but early 2020 saw daily usage figures of lower than 30 million. Other (read: better) services like Zoom and Discord have diluted the market despite Skype's huge head start. Not even specialized hardware could save it.

05 So, So Many Linux Distributions

Linux is a fantastic platform, with a number of highly recommended distributions such as Arch or the excellent elementaryOS. However, the open-source nature of Linux means that it has seen some dodgy iterations. Some are simply unimpressive, like Mint, which runs like Ubuntu with a few limbs lopped off, but others reach beyond the territory of merely bad and into the domain of weird and twisted. The bizarre Moebuntu plasters the classic Ubuntu UI with anime girls and pastel colors, while the now-legendary Hannah Montana Linux tried to entice young women into the computing field with a bright pink desktop and images of the Disney Channel-era Miley Cyrus character.

Some aren't quite so innocent, though, with more dubious distros like the North Korea-endorsed Red Star OS, which entirely restricts access to the wider internet. Then there's "Ubuntu Satanic Edition," supposedly the OS of choice for Satanists around the world.

04 OnLive

OnLive was a cloud gaming platform that promised to do everything Stadia has difficulty doing today. Suffice to say, things did not go well. Mixed critical reception and poor performance thanks to a fundamental lack of

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internet infrastructure doomed the product from the outset, despite a number of decent features, such as download-free game demos and broad device compatibility. Most games experienced input lag, as the average American internet speed was below 10Mbps during OnLive's main period of operation. An OnLive home console was launched in 2010, but failed to make any impact.

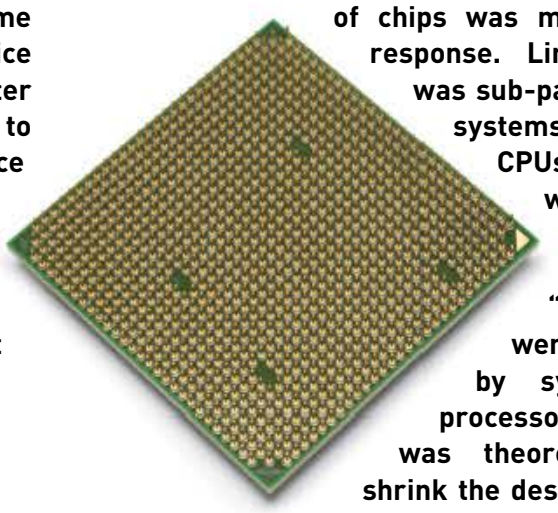
Although the company was supposedly doing well and expanded into the UK with some success, plans to bring the service to Europe were scuppered after mass layoffs in 2012. An attempt to revive the firm with a new service called CloudLift failed. The dissolution of the company saw its assets sold to Sony for a fraction of their original worth, despite being valued at nearly $2 billion at its peak.

03
Google Plus

Google Plus, taken from us before its time. Google has something of a reputation for abandoning products and services once they are deemed unprofitable (hello Google Wave), but the final Google property on our list kept stumbling onwards for years, somehow surviving data leakage scandals and poor user retention, until Google finally took it out back and put it down with a battered old Winchester 73 in 2019.

It's almost a shame, especially when seeing how other Google properties like Drive and Gmail have flourished over the last few years and evolved into an excellent web of interconnected services. G+, as it was often called, was supposed to be the Google-powered social network, going up against both platforms like Facebook and more professional services like LinkedIn. While initial growth was solid, interest waned as its competitors grew. Censorship in China and Iran only drove controversy, but the most damning thing was undoubtedly Google's attempts to tie YouTube commenting to G+ accounts. People were extremely unhappy, and the mandatory Google Plus integration was scaled back a few years later.

02
AMD Bulldozer



The Bulldozer processors (such as the AMD FX-8150) were a brand-new type of chip from AMD, not building on previous versions but instead starting with a fresh approach to the processor's microarchitecture. Released in 2011, the new family of chips was met with a mixed response. Linux performance was sub-par, while Windows systems saw the Bulldozer CPUs glugging down watts like a sailor at closing time.

By using "modules" that were recognized by systems as two processor cores, AMD was theoretically able to shrink the design without losing performance. This didn't pan out so well, though, as the new chips just couldn't hit the performance levels needed. Although Microsoft released a handful of updates over the years that improved Bulldozer performance in Windows, the damage was done. Supply issues and prominent Intel marketing moves dogged the Bulldozer chips for years, and reviews were hardly overflowing with praise. When AMD was embroiled in a false advertising lawsuit in 2015 over the description of the processor modules as "dual-core," it seemed like a final blow from Bulldozer. It was the last we ever heard of AMD's first HGV-themed processor family.

01
Steam Machines

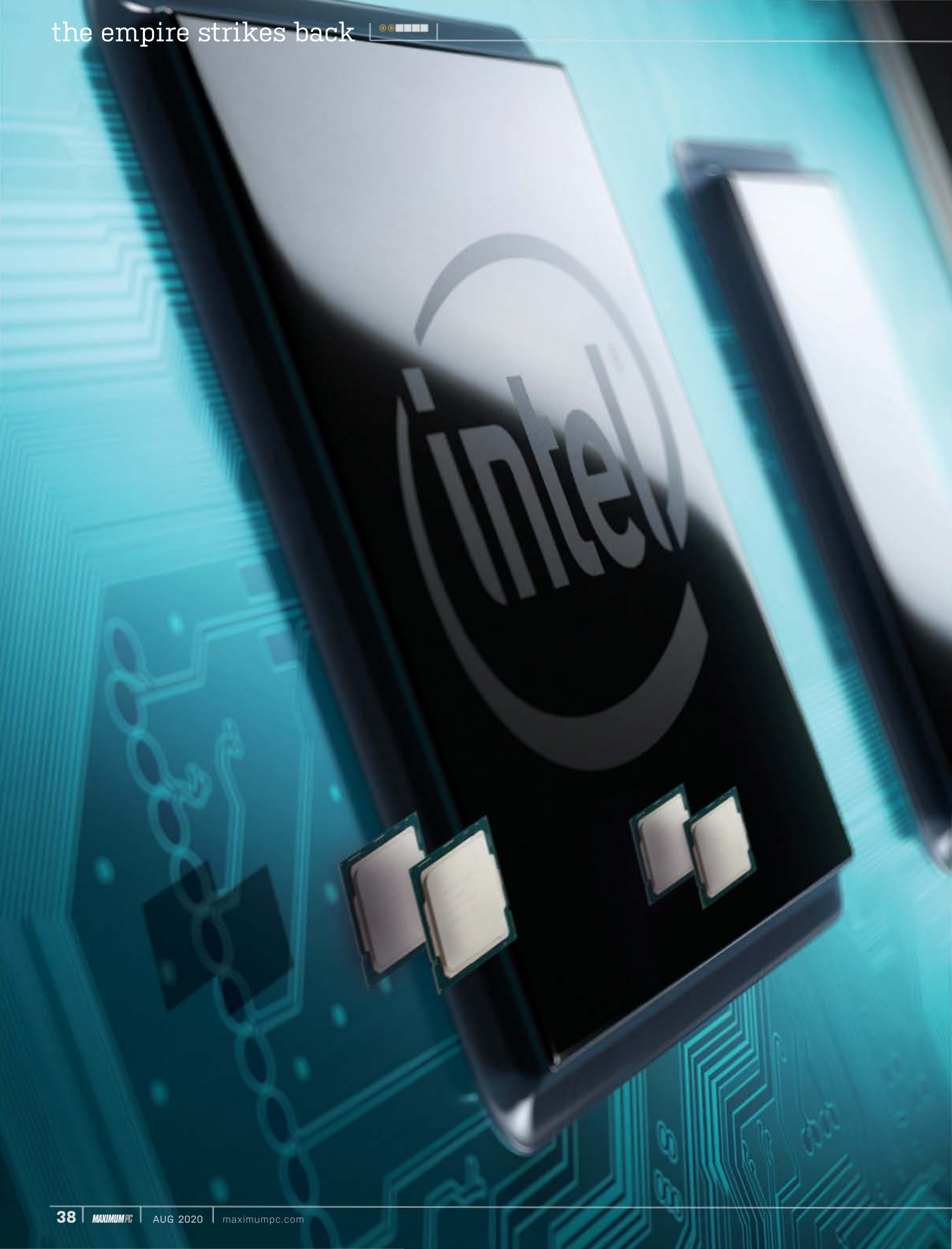
We know we're verging into console territory here, but let's be honest: Steam Machines were always just lightweight gaming PCs in a home console shell, perfect for couch gaming. They promised a lot, from access to the vast library of games available on Steam, to a price point competitive with mainline consoles. It also launched alongside the Steam controller, a somewhat polarizing piece of hardware but theoretically a good idea. These systems also came with SteamOS, a new Linux-based operating system that had been built from the ground up for gaming. On paper, they should've worked.

But then reality had to go and rough it all up. A messy array of Steam Machines were released at once, instantly muddying the waters for console gamers who were considering making the switch. They weren't any cheaper than home consoles, and compact designs led to average performance. Demand was mediocre at best. Although Valve kept updating it for years, SteamOS never became a household name.

Steam Machines were beset with one difficulty after another. Free upgrades to Windows 10 served to further lessen the need for SteamOS. Many Steam Machine models were criticized for their lack of easy upgradeability—a cornerstone of the PC gaming community. Valve began to distance itself from manufacturers and eventually released Steam Link, which enabled the streaming of games from a PC to a TV.

Valve may have found some success with the new Index VR headset, but we feel comfortable in declaring Steam Machines the number one PC hardware flop of the last 20 years.

© AMD, STEAM


intel

THE EMPIRE STRIKES BACK

After more than a decade of dominance, Intel has fallen behind its main rival, AMD. **Jeremy Laird** investigates where Intel went wrong and how it will fight back

WHAT, EXACTLY, has happened to Intel? The once unassailable leader in both PC processors and chip manufacturing generally now looks second best by almost every conceivable technological metric. AMD's CPUs appear cleverer. TSMC's manufacturing technology seems more advanced. Intel, it seems, has completely lost its way.

Even in the mobile PC space, which Intel has absolutely owned for decades, AMD's new Renoir APU has the edge. Likewise, how is it that AMD has offered PCI Express 4.0 on desktop PCs for a year, but Intel hasn't even announced future support for what is a crucial high-speed interconnect?

Things are so bad that Apple is said to be planning to ditch Intel in favor of its own ARM-based processors. Worse, Intel itself is rumored to be considering TSMC as a manufacturing partner for selected future products, including its first consumer graphics card in decades. Truly, that would be the ultimate humiliation.

Or would it? Last year, despite those issues, Intel enjoyed record revenues of $72 billion. In fact, in pure commercial terms Intel's main problem has been keeping up with demand for its chips from so-called hyperscalers. That's the likes of Amazon, Microsoft, Google, Facebook et al, who simply can't get enough of Intel's Xeon processors. Meanwhile, there are good reasons to think that Intel will soon be back on track when it comes to both chip manufacturing and CPU architectures.

WHAT SINGLE thing summarizes Intel's woes? Try "10nm." Chip production technology isn't Intel's only failing—a strong case could also be made for the company becoming ever more complacent over the past decade when it comes to CPU architectures—but 10nm? What a disaster.

By 10nm, of course, we mean a specific production process or node used to manufacture computer chips. The measurement 10nm refers, in theory, to the size of the smallest features inside the chip. In practice, the monikers attached to production processes and the actual size of components like transistor gates inside a PC processor have become somewhat estranged in recent years. There probably isn't any individual feature that actually measures 10nm within a "10nm" Intel CPU.

That arguable lack of direct correlation between feature size and the description of a given node becomes even more problematic when it comes to comparing process technologies from competing manufacturers. But more on that in a moment. For now, what matters is that 10nm is Intel's latest production process and surely its most troubled. Originally, 10nm was due to arrive way back in 2015. Here, in the second half of 2020, 10nm still only makes up a small minority of Intel's production. You can't buy a 10nm desktop or server CPU from Intel. Only mobile processors for laptops and tablets have moved to 10nm, and even then just some of Intel's low and ultra-low-power range have moved to 10nm. Others have been refreshed on 14nm.

The context for all this—the self-imposed metric by which Intel can unambiguously be said to have fallen short—is Moore's Law. For the uninitiated, Moore's Law is the assumption that computer chips either double in complexity or halve in cost—or some mix of the two, depending on your objectives—every couple of years. It dates back to observations made between 1958 and 1965 by Intel co-founder Gordon Moore. It has since proven remarkably prescient. At least it did until the last decade, when the first signs emerged that chip engineers were beginning to bump up against the laws of physics.

But the wider trials and tribulations of semiconductor manufacturing—as individual transistors approach the size of a handful of atoms and begin to suffer from arcane quantum effects such as tunnelling—are a story for another day and another feature. It's the specifics of Intel's 10nm process that matter for now.

Very likely, Intel's problems boil down to a combination of over-ambition, the end of the line for a certain manufacturing technology, and, just maybe, complacency and a lack of investment. According to Intel CEO Bob Swan, Intel's problems with 10nm are "somewhat a function of what we've been able to do in the past, which in essence was defying the odds. At a time when it was getting harder and harder, we set a more and more aggressive goal. From that, it just took us longer."

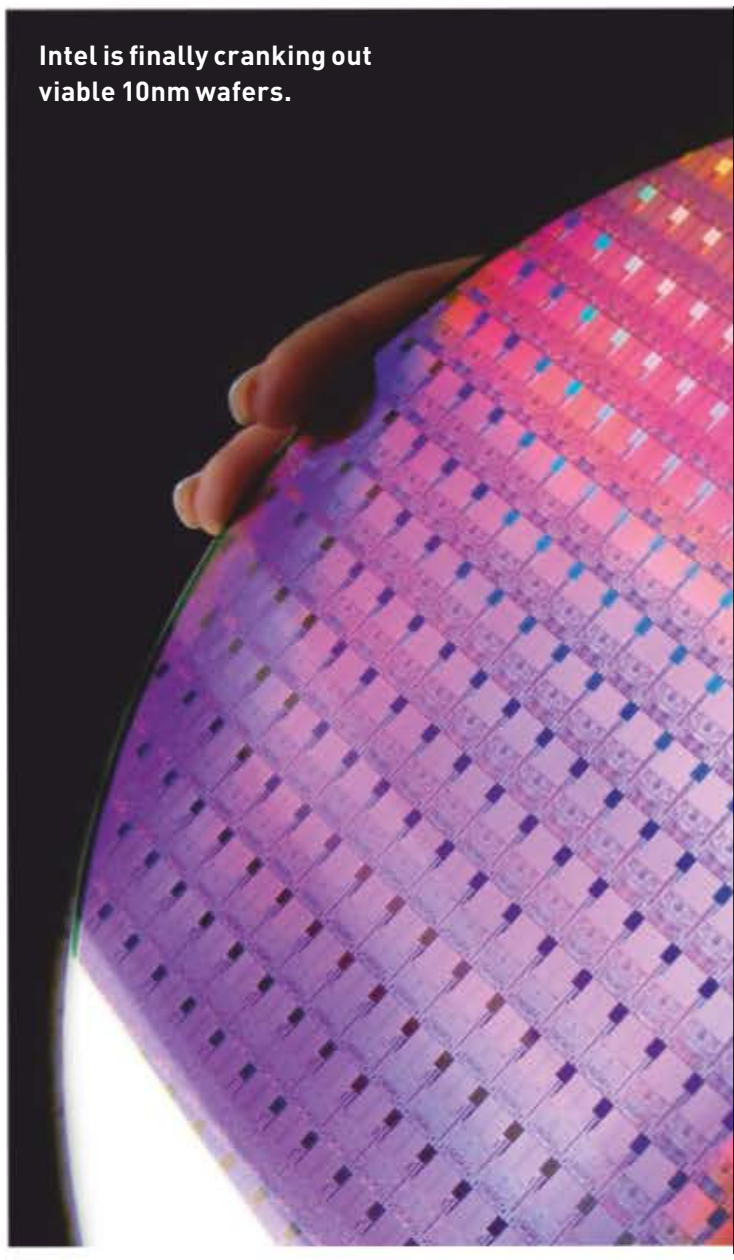
CHIP AMBITIONS

For the 10nm node, that aggressive goal means improving transistor density by a factor of 2.7. In other words, for a given area of processor die area, the 10nm node contains 2.7 times as many transistors as the previous 14nm node. If it's more numbers you want, the 14nm process clocks in at 37.5 million transistors per square millimeter, while the 10nm node achieves just over 100 million by the same metric. That dramatic advance in density makes 10nm demonstrably more aggressive than other recent node transitions from Intel. The 2.5 times step from 22nm to 14nm was quite impressive, but 32nm to 22nm represented a density improvement of 2.1 times, while 45nm to 32nm was pegged at 2.3 times.

Comprehension of these variable density improvements helps to explain the aforementioned difficulty comparing production nodes from competing manufacturers. By way of example, Intel's 10nm density of 100.8 million transistors per square millimeter is actually slightly superior to the 96.5 million transistors achieved by rival manufacturer TSMC's initial 7nm node (TSMC claims 113.9MTr/mm2 for its refined 7nm node). All three of Samsung's 7nm nodes also come in at slightly under the 100 million mark.

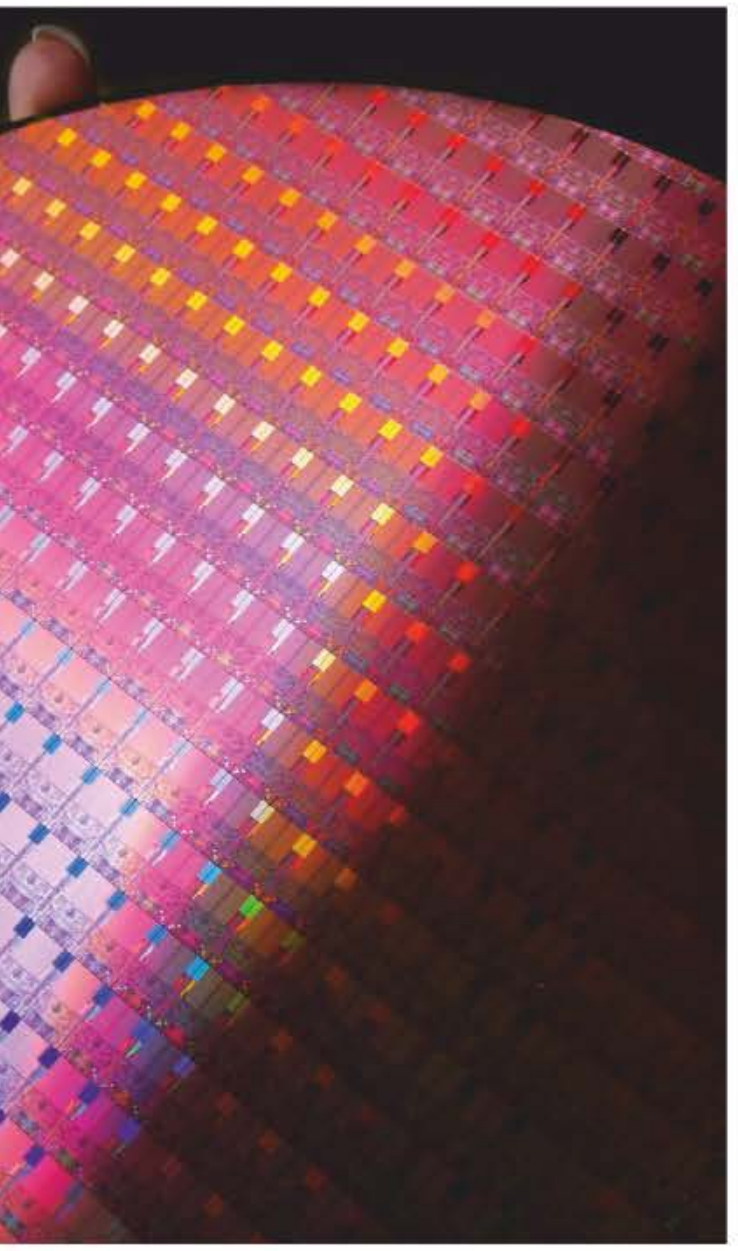
The point is that Intel's 10nm was very ambitious—ambitious enough that in 2017 Intel applied the "Hyper Scaling" label to the increase in density it achieves. With the benefit of hindsight, that ambition now looks like overreach. That's because Intel made 10nm its final process node based on existing deep ultraviolet lithography (DUV) manufacturing technologies. To cut a long story short, the size of features in a chip are a function of the wavelength of light used in the lithography processes that etch features into the surface of silicon wafers, from which the likes of PC processors are eventually cut.

It's not a direct relationship. Various techniques and tweaks such as masks are used, in effect, to act as multipliers, reducing feature sizes beyond the actual wavelength of the light in question. Chip production facilities, or fabs, with the most advanced DUV technology, including Intel's 10nm products, use ultraviolet light with a wavelength of 193nm. Even so, there is a limit to the transistor density that can be achieved with a given wavelength. Intel was pushing up against that limit with 10nm using DUV technology.



Intel is finally cranking out viable 10nm wafers.

> "Intel has upped the ante to 10 cores for mainstream desktop processors



THE ULTIMATE HUMILIATION?

Is Intel planning to use TSMC to manufacture its new Xe graphics?

As rumors go, this is a real eye-catcher. Could Intel be in negotiations with rival chip maker TSMC to manufacture its upcoming Xe graphics chips? Ostensibly, it would be the ultimate humiliation, the final insult to the troubled 10nm node. Intel's 10nm node is so bad, the cries will go, they skipped their own fabs and went outside the company to get access to a decent manufacturing process.

Of course, it is just a rumor. Were it to happen, very likely it would be a temporary measure. You could even argue that it is the prudent, risk-averse option, given that TSMC has been producing nearly all the world's high-performance graphics for a decade or more. If you wanted to de-risk GPU manufacturing, TSMC would be your choice.

Anyway, at worst it would buy time for Intel's 7nm process to come on stream. Moreover, the GPU market is notoriously difficult to break into. The last time Intel tried, with the ill-fated Larrabee architecture, consumer variants were cancelled before they even made it to market.

In that context, expectations for 1st-gen Xe products probably ought to be kept quite firmly in check. These products are perhaps better thought of as tools to help Intel accrue feedback, polish its drivers, and learn from any mistakes before the real push comes with 2nd and 3rd-generation products later down the line.

The result, infamously, has been a delay of as much as five years, a relative aeon in the context of Intel's track record and Moore's Law. Even now, there are signs that 10nm isn't what it ought to be. The new 10th-generation Ice Lake mobile processors, for instance, actually clock lower than their 14nm predecessors. The fastest 10nm Ice Lake Core i7-1065G7 CPU tops out at 3.9GHz. The 8th-gen Core i7-8665U is fully 900MHz faster. That's a heck of a gap, and it's symptomatic of a production process that isn't quite right.

Another indicator that 10nm still isn't what Intel would really have wished for is the peculiar doubling up of 10th-gen low-power CPUs. Alongside those Ice Lake chips is the new Comet Lake family, also dubbed 10th generation. Like Ice Lake, mobile Comet Lake comes in low and ultra-low-power formats. But unlike Ice Lake, it is a 14nm family, not 10nm, and extends to six-core models and up to a peak clockspeed of 4.9GHz.

The upshot of which is that, right now, you can buy a laptop with a CPU branded with Intel's latest 10th-gen logo. But what's inside can vary dramatically. If it's dual or quad-core, it may be low or ultra-low power. It might be 14nm or 10nm. It could be based on the Skylake architecture from 2015, or a brand new architecture with the latest Sunny Cove CPU cores, as seen in Ice lake.

ARCHITECTURAL WOES

Speaking of Sunny Cove, it brings us rather neatly to Intel's other major failing beyond manufacturing, namely architectures. Up until the release of 10th-generation Ice Lake CPUs for ultra-portable laptops late last year, Intel's entire CPU product stack for desktops, laptops, and servers was based on the 14nm process that debuted in 2014, and the Skylake architecture of 2015. Both have been revised on numerous occasions, but the updates were just that—revisions, not step changes.

What's more, since at least 2008 and the Nehalem architecture, Intel has offered a maximum of four cores for mainstream desktop processors. You could argue that quad-core for mainstream desktops even predates Nehalem. But at the very least, Intel's mainstream offerings remained quad-core at best from 2008 until the release of the Coffee Lake update to Skylake in 2017, and with it an increase to six cores. For nearly a decade, Intel didn't increase its mainstream core count.

Fast-forward a little over two and a half years, and Intel has upped the ante to 10 cores for mainstream desktop processors with Comet Lake, yet another respin of Skylake and yet another family of 14nm processors. So, that's nothing for nearly 10 years, then a 2.5 times increase in the space of just a few. The reason for this dramatic increase in core count after such sustained stagnation? That'll be AMD's Zen architecture and Ryzen CPUs, the first generation of which arrived in early 2017. Put simply, Intel got somewhat lazy during the pre-Ryzen period, when AMD offered limited competition.

Even at 10 cores, of course, Intel is still a long way behind the 16 cores AMD currently offers in the mainstream desktop space with its 3rd-generation Ryzen processors, which have the benefit of TSMC's cutting-edge 7nm process. In the mobile space, it doesn't look much better for Intel. AMD's latest 7nm Renoir APU brings eight Zen 2 cores into the low-power 15W segment. Intel can only muster a six-core Comet Lake Core-i7 10810U to compete, a processor with a mere 1.1GHz baseclock. The 15W Ryzen 7 4800U packs eight cores and a 1.8GHz baseclock. It's not a flattering comparison.

© INTEL

PLOTTING A ROUTE OUT OF 10NM

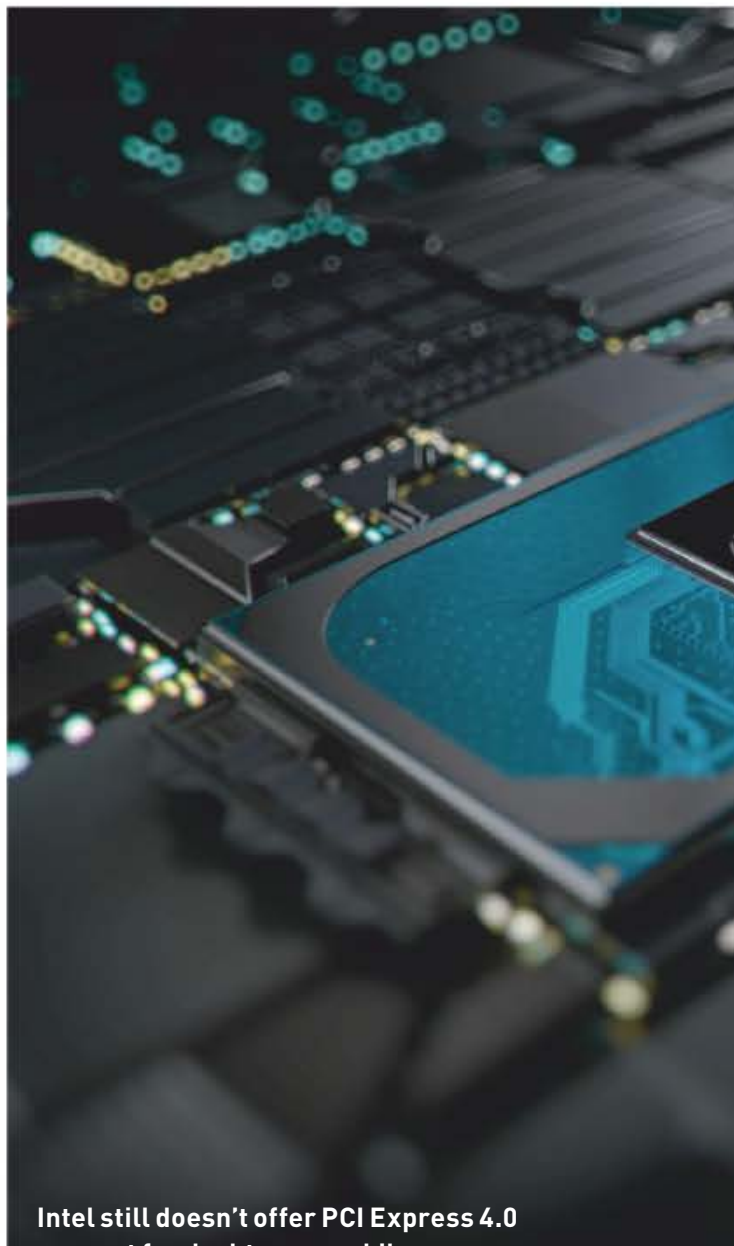
Intel's roadmap to 7nm and beyond

If Intel isn't going to be fully on track before its new 7nm node, due out late next year, and realistically not a source of really high-volume manufacturing until 2022, what are Intel's plans to stay competitive between now and then? After all, AMD won't be standing still and says it will release another iteration of its Ryzen CPU, powered by Zen 3 architecture, later this year.

When it comes to Intel roadmaps of late, suffice to say that everything is subject to change. However, all the indications are that Intel will stick with 14nm for its next family of desktop processors thanks to an approach known as backporting.

Intel will take the Willow Cove architecture, originally designed for the 10nm node, and backport it to 14nm. Willow Cove is thought to offer roughly 25 percent more performance per clock than Skylake, making for very powerful CPU cores. The new chips, known as Rocket Lake, are due out later this year and are expected to top out at eight cores. Apparently the large Willow Cove CPU cores are quite power-hungry when manufactured on 14nm, preventing Intel from going beyond eight cores. With Rocket Lake, Intel will finally offer a desktop CPU with support for the PCI Express 4.0 interconnect.

Then comes the first 10nm architecture, Alder Lake, which gets faster Golden Cove cores. But the radical departure will be a new big.LITTLE philosophy, which combines small, power-efficient cores with larger, high-performance cores— so Atom cores alongside Golden Cove cores.



Intel still doesn't offer PCI Express 4.0 support for desktop or mobile.

LOOKING TO THE FUTURE

So that's the case for the prosecution. It hasn't been a great few years for Intel from a technology perspective. As Intel's CFO, George Davis, said of the 10nm debacle: "This just isn't going to be the best node that Intel has ever had. It's going to be less productive than 14nm, less productive than 22nm." But is Intel's predicament really that disastrous?

In pure financial terms, the resounding answer is no. In fact, not only is the situation not that bad, there's no problem at all. 2019 was a record year for Intel revenues. Since the middle of 2018, far from sales falling off due to technological stagnation, Intel has been struggling to keep up with demand for its 14nm chips.

Dig a little further into the details, and it seems likely that at least part of the problem is still technological. Intel's server chips have increased in core count dramatically during the 14nm era. Intel now offers as many as 28 cores in a single processor die. More cores on the same process means fewer CPUs can be extracted from a single wafer, which in turn can constrain supply.

But however you slice it, Intel has not been suffering financially, which is the most important reason why you can expect Intel to respond in terms of product and technology. As for resources, Intel retains a huge advantage over its only rival in the PC processor market, AMD.

That response has already started to show. Ice Lake debuted Intel's first new CPU core architecture since Skylake, known as Sunny Cove. It delivers performance-per-clock improvements of around 18 percent over the Coffee Lake revision of the Skylake architecture.

But that's just the beginning. Central to Intel's architectural resurgence was the addition of Jim Keller, heading up Intel's CPU development team. Although he's departing in the next six months, it's hard to disregard what his experience may bring. Keller is one of, if not the most, highly regarded processor architects in the business. He made his name as lead architect of AMD's K8 technology, the chip otherwise known as the Athlon 64, and the first CPU from AMD that really took the fight to Intel. Keller later worked for Apple, kick-starting the series of in-house ARM-based processor designs that have dominated the smartphone and tablet segments. In 2012, Keller returned to AMD, driving the development of Zen and once again giving AMD the tools to fight Intel. After a brief stint at EV maker Tesla, Keller arrived at Intel in April 2018.

Given the lead times between the initial design and conception of a CPU architecture and its inclusion in products available to buy, it's very unlikely that the new Sunny Cove cores inside Ice Lake processors are Keller's work. The same is likely true of the follow-up to Sunny Cove, known as Willow Cove, which may appear later this year in the Rocket Lake family of 14nm "backport" CPUs and is not thought to be a major advance on Sunny Cove.

Next up is Golden Cove, which will be a bigger step forward late next year when it forms the basis of Intel's upcoming Alder Lake CPUs. But even Golden Cove probably isn't what you might call a pure "Keller" processor. For that we'll have to wait for 2022 or 2023 and Ocean Cove, although his impending departure from Intel will mean his influence on even this project will likely be somewhat reduced.

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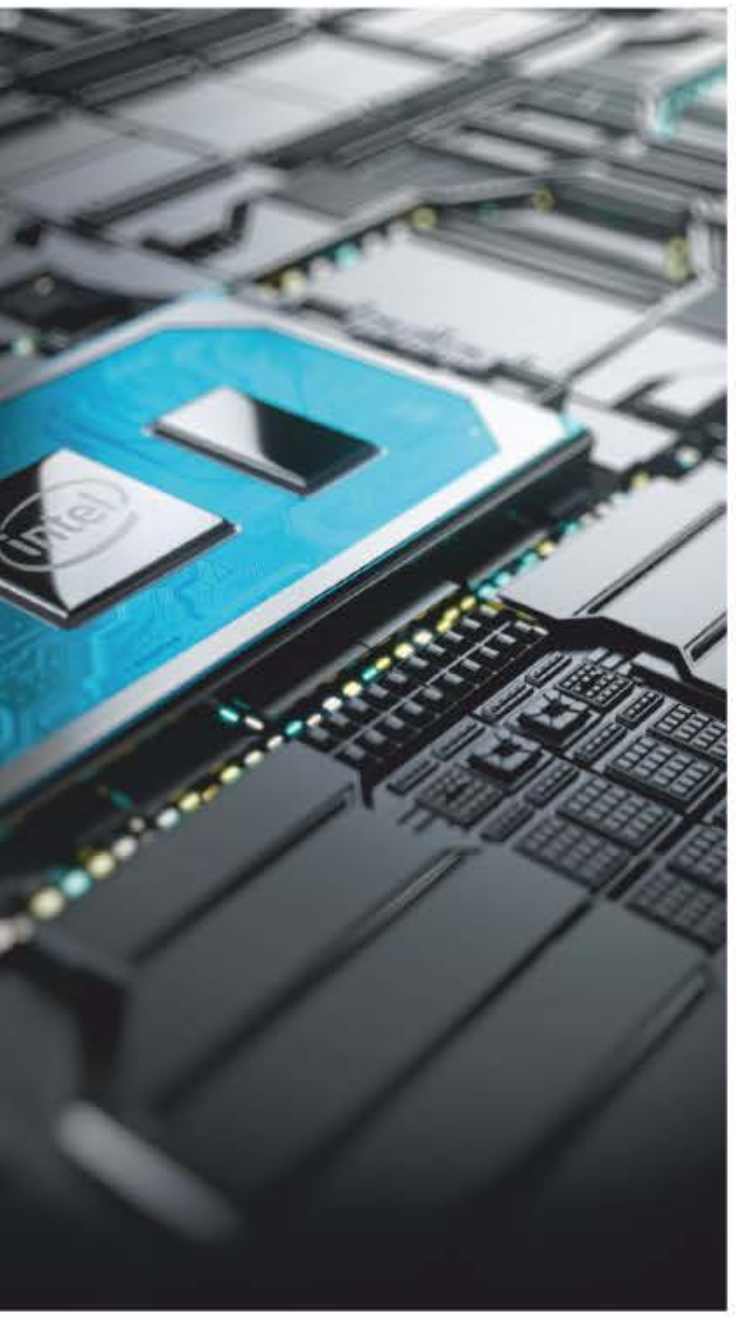

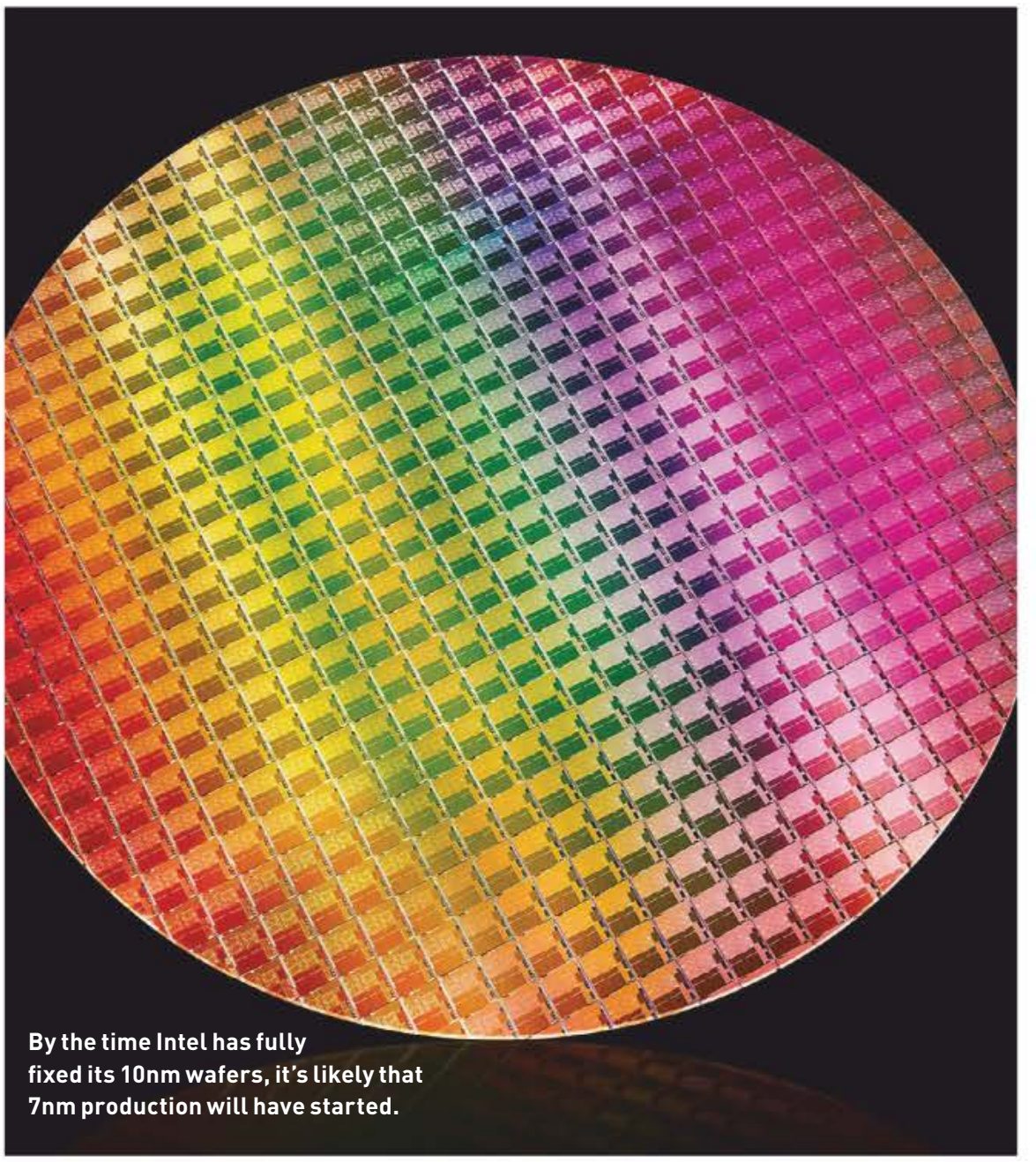

By the time Intel has fully fixed its 10nm wafers, it's likely that 7nm production will have started.

Almost nothing official is known about Ocean Cove. Recently, rumors emerged indicating that Ocean Cove could deliver as much as 80 percent more performance per clock than Skylake. For now, that is speculation. All we know for sure is that Keller has an outstanding track record and that Intel's roadmap is more aggressive now than it has been for many years. As Keller himself has said, "We have a roadmap to 50 times more transistors and huge steps to make on every single piece of the stack."

Meanwhile, the follow-up to the troubled 10nm node, Intel's upcoming 7nm process, doesn't face the same limitations as 10nm. For 7nm, Intel is transitioning to extreme ultraviolet lithography (EUV) with wavelengths as small as 13.5nm. 7nm, in other words, is a fundamental reset. Time will tell, but Intel is certainly making bullish predictions for 7nm and beyond.

Intel plans more overlap between its upcoming nodes, including 7nm, 5nm, and the processes that follow. That means pressing on with new technology as opposed to milking nodes for every last cent, even if that comes at an R&D cost. "In order to regain process leadership, we had to accelerate the overlap between 10nm and then 7nm and 5nm. Starting particularly in 2021, the performance of 10nm will intersect with investment in 7nm, and we're also willing to start an investment in 5nm, all of those elements combined," says Intel CFO George Davis.

In fact, Intel expects to return to a two-year release cadence based on the new EUV era, starting with 7nm late next year and extending all the way to the release of the 1.4nm node in 2029. "I think EUV will give us back a degree of the traditional Moore's Law cadence," says Davis.

Taken together, it paints a picture of Intel reverting to the norm of creating the most advanced processor architectures and the world's fastest CPUs. Whether that happens is another matter. AMD is arguably in a better position now than ever before to maintain the pressure, even if Intel significantly ups its game. AMD's architecture roadmap, including the likes of Zen 3 and Zen 4, combined with TSMC's manufacturing prowess, will make for stiff competition. But we'll not be betting against Intel. After all, the last time Intel stumbled, back in the dying days of NetBurst and the Pentium 4, its response was the Core dynasty and a decade-long domination of the CPU market.

> "Next up is Golden Cove, which will be a bigger step forward late next year

TECH PORN

1 STEALTH MODE

No liquid-cooled build is completely silent, but the Vanquish does its very best. The built-in EK-Vardar fans are able to keep to a relatively low RPM even when overclocking the components, thanks to the effectiveness of the dual-block liquid-cooling loop. Slower fans mean less noise pollution, and the pump built into the distribution plate isn't too loud either.

2 BLOCK PARTY

The CPU and GPU water blocks are EK's universal models for AMD chips and RTX 2080 graphics cards, which means you can theoretically upgrade the parts later on. Not that you'd want to: The stock RTX 2080 Super is already one of the best GPUs on the market, and the Ryzen 7 3800X brings 16 threads to the party.

EK Fluid Gaming 275-AG Vanquish

WHEN IT COMES TO liquid cooling, EK is the genuine article. Cooling kits and water blocks are the first thing this Slovenian brand offers, but today we're going a step further, taking a look at one of EK's fully liquid-cooled gaming systems. This is the 275-AG Vanquish, an absolute powerhouse for gaming, fitted with an EVGA RTX 2080 Super and AMD Ryzen 7 3800X, along with 32GB of high-speed RAM. Sit down for this: It costs $2,700. Yes, that's a lot of money to drop on a gaming rig, but consider that the CPU and GPU cost $1,200 to buy separately. The Vanquish is expensive, but you get plenty of bang for your buck.

Of course, the main draw here isn't just the incredibly high-end components. The Vanquish uses a complete custom loop for cooling its components, built from EK's own liquid-cooling parts to ensure quality. A clear distribution plate at the front acts as a reservoir, spreading the included transparent CryoFuel coolant across the face of the system before piping it through solid tubing to the CPU, GPU, and roof-mounted radiator. There's very little setup to do here; all of EK's pre-built machines come drained, with the necessary coolant packaged alongside it. The quick-start guide is easy to follow, making this an ideal first step for any inexperienced PC gamer looking for a liquid-cooled build.

It's a polished product, with pro design quality. The robust Lian Li case keeps things tidy, with a dedicated metal channel that runs the height of the case behind the motherboard, where the power and I/O cables can be bundled together. **–CHRISTIAN GUYTON**

3 LIGHT HOUSE

The entire front panel illuminates beautifully thanks to digital RGB lighting that is liberally peppered throughout the case. The memory, water blocks, distribution plate, and fans can all be synchronized to put on an awesome visual display, with LEDs that are powerful enough to shine even in a well-lit room.

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HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH

REPLACE YOUR FANS!

If you've got a system that you regularly use (or an always-on machine), consider how long you've had it for. A good-quality drive or processor can last for ages, but case and radiator fans are rarely rated for more than five years of operation, and less for systems that are constantly running. New case fans aren't too expensive and are a worthwhile investment to keep older systems running cool.

CHRISTIAN GUYTON
STAFF WRITER

LIQUID DIET

The EK Liquid Gaming PC we've featured in Tech Porn this issue is a beaut, even if she is currently taking up a chunk of my living room table as I write this from lockdown. I'm personally not a liquid-cooling fiend like our dear editor, but I have to respect the workmanship that goes into these systems. Filled with clear coolant and powered on, it seems like the light that pours out of it might lead you to a pot of gold.

I do see the appeal of liquid cooling: It represents the cutting-edge of consumer PC hardware, the ultimate in technological coolness (no pun intended). If you rock a fully liquid-cooled gaming system decked out in RGB, you're probably the envy of your friends. Competitive overclockers use custom liquid loops and refined coolant to keep chips from throttling even as they're pushed to ridiculous extremes.

Liquid cooling is hard work, though. It's complicated, often impractical, and requires far more routine maintenance than AIOs or basic air coolers. I do think that the EK Vanquish PC is amazing, but can I be bothered with the hassle of draining, cycling, and refilling my home system every six months? It would be something to keep me busy inside my little apartment, but I'd rather stick to simply blasting some compressed air around my case every now and then. What do you think, readers?

MAKE – USE – CREATE

52
How to silence your PC for less than $20

54
Start and secure your own WordPress blog

60
Build a silent audio-recording PC for a home studio

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IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

iPhone SE 2020

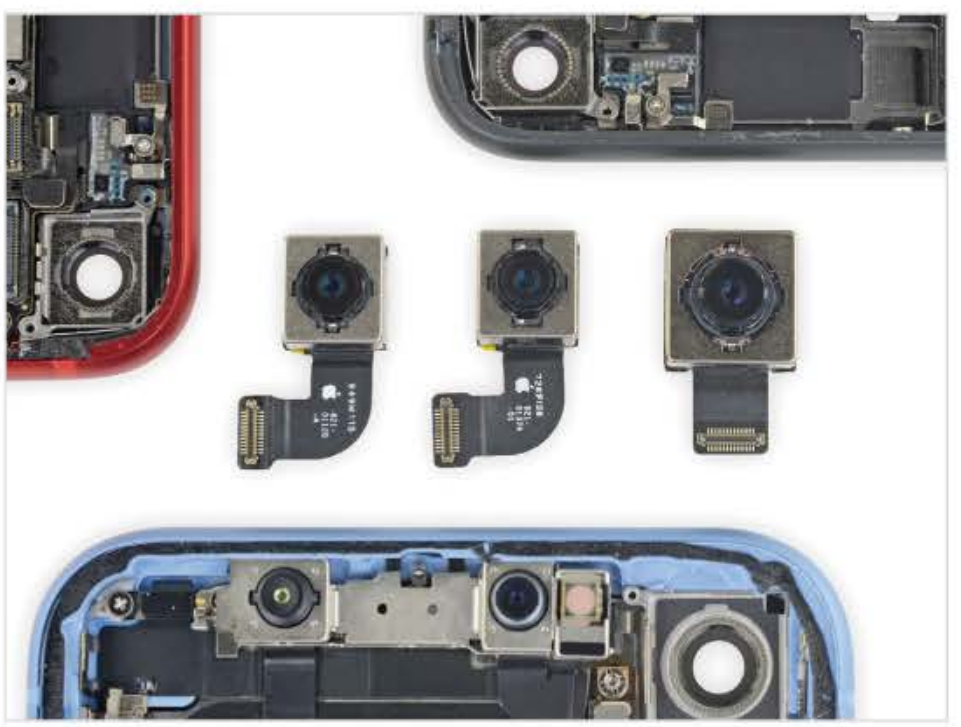
Sometimes when tearing down iPhones, we get a little board. Like this one!

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

The SEquel to the popular budget-friendly iPhone has finally arrived. It's been called a "parts bin" phone, and we really hope that's true! The specs certainly seem to agree with that.

Left: iPhone SE. Middle: iPhone 8. Right: iPhone XR.



BACKGROUND

Second Edition? Smallish Edition? We're not sure what "SE" stands for, but it wouldn't be an iPhone teardown without a little mystery. And this 2020 iPhone SE is $400 worth of smartphone conundrum—old-school on the outside and purportedly pretty modern on the inside. Let's tear down...

MAJOR TECH SPECS

- A13 Bionic SoC with a third-generation Neural Engine
- 4.7" Retina HD display with 1334 × 750 resolution (326 ppi), True Tone, and wide color gamut (P3) support
- 12MP wide-angle rear camera at f/1.8, and a 7MP f/2.2 front-facing camera
- Gigabit-class LTE with 2x2 MIMO and 802.11ax Wi-Fi 6 with 2x2 MIMO + Bluetooth 5.0 + NFC
- Home button with 2nd-generation Touch ID sensor
- IP67 dust/water ingress rating

KEY FINDINGS

- The new SE is slightly smaller than the 11 Pro, but what you really notice is the weight difference—the SE is 21% lighter. First we submit the SE for X-ray inspection along with its predecessors, the original SE and iPhone 8. Apart from a very subtle antenna rework and moving a few chips around the logic board, we can't tell what Apple's been up to yet.
- We'll keep the iPhone 8 comparison going and see just how similar these phones are. With both phones open, they look like doppelgängers. Cross-compatible parts could be a real boon for third-party repair. The Taptic Engine and main speaker are interchangeable between the 8 and SE.
- Turning to the battery, the capacity is the same as in the iPhone 8 at 6.96 Wh. That's up from the original SE's 6.21 Wh, and much lower than the iPhone 11's 11.91 Wh. Unfortunately, the connector has changed, so batteries cannot be swapped between models.
- When Apple retired 3D Touch in the iPhone 11 Pro series, it made the displays thinner and batteries thicker. The new SE also lacks 3D Touch, but the batteries are the same size. What was the sacrifice for? Probably to save money. Or Apple wants us to forget that 3D Touch ever happened.
- Where does the main camera come from? Half the rumors say iPhone 8, half say XR, and a forbidden third half say something else. The SE's sensor is smaller than that in the XR. It's likely an iPhone 8 sensor with A13 image processing.
- Back to that display—the iPhone 8 display looks identical to the SE's. Are they secretly the same? Not so fast! On 3D Touch screens, we'd normally find a chip on the back that drives the parallel plate capacitors. The iPhone SE display doesn't have that chip. And the layer of capacitors? We start peeling off parts in an attempt to confirm... no 3D Touch. The two displays are functionally interchangeable, which is amazing considering the difference in hardware.
- Repairability score: 6 out of 10 (10 is easiest to repair). The two most commonly replaced components, display and battery, are straightforward to access with the proper tools. Most components are modular and independently replaceable, including many that are cross-compatible with the iPhone 8. IP67 seals complicate repair. While overall it is repair-friendly, you'll still need up to four different driver types, and the glass back is impractical to replace.

How to Silence your PC for Less Than $20

YOU'LL NEED THIS

YOUR PC
Compressed air, thermal paste, and patience.

CONTRARY TO POPULAR BELIEF, you don't actually need to spend a whole wallet full of cash to make your PC run silently with liquid cooling and big radiators—which is great, because with the human malware that is Covid-19 going around, chances are your local PC shop won't accept cash, and you'll also prefer to save it for a rainy day. But now we've come to a non-metaphorical rainy day, and you've decided it's time to do something about that loud PC of yours. So here's how you can silence your PC for under $20 (your results may vary).

A wonderful thing is that almost every PC—laptops not included—comes with cooling gear that is, at least moderately, over-dimensioned for the task. Like your car, it has to be able to keep running properly on a hot day, which means that if it's not too warm it can run silently. There are several steps you can take to silence your PC without spending big bucks, and though you don't have to go through all of them, completeness will yield the best results. **–NIELS BROEKHUIJSEN**

A

1 CLEANING

To start off, you'll have to unplug your PC and take it to a suitable workspace—preferably without carpeting or where static electricity isn't an issue—and clean it. Whip all the panels off that bad boy, wield your can of compressed air, and get to cleaning. It's probably a grimy, dusty mess in there by now, and all that gunk isn't doing airflow any favors.

›› If you don't want to get dust all over your living room, you can use a vacuum cleaner to catch it as you blow it out with the compressed air. But be aware that vacuums can generate quite a bit of static electricity, so maintain a safe distance between its nozzle and your PC.

›› During cleaning, hand-wash the dust filters (making sure to let them dry before re-installing), and double-check that you get into all the little nooks and crannies in the heatsinks with that tinned air. If you have to take things apart [**Image A**], so be it, but spending a little extra time on this pays off in the end, both in terms of looks and performance.

2 GREASE 'R UP: REAPPLYING THERMAL PASTE

Now that your PC is all clean and looking good as new, it's time to dig in a little deeper. As your PC ages, the thermal paste between your CPU, GPU, and their coolers ages with it. Thermal paste typically has an ideal operational lifetime of about two years, or less if you're gaming regularly. Sure, it can do its job beyond that time, and most people will let it, but it dries out and loses its ability to efficiently transfer heat between the chip and the cooler, which is one of the reasons why your PC will run louder as temperatures increase.

›› Note that we only recommend replacing thermal paste once your PC is out of its warranty or you are aware of the ramifications. Replacing it in a pre-built PC or graphics card within the warranty can reduce your chances of a successful RMA, should something go wrong in the process or break later on.

›› Replacing the thermal paste on your CPU is a simple process. Uninstall your CPU cooler and clean up both the cooler and CPU's heatspreader with an old rag and some rubbing alcohol. If your paste is dry and crumbly, you know it is long overdue for replacement. Once the rag comes off clean without any old paste, you're ready for the next step.

›› To apply fresh paste, place a pea-sized drop of your new thermal paste (or from an old tube that you still have) on the center of your processor [**Image B**], and re-install your CPU cooler, following a crisscross pattern

B

UNPLUG YOUR FANS!

A tip: If you're using a vacuum cleaner or compressed air on your fans, it's advisable to unplug your fans from the motherboard—the compressed air can make them spin fast, making the motor act as a generator and send power into your precious PC, potentially damaging the onboard fan controller. Most systems can handle this fine, but it's hardly any added effort in the process, so don't let laziness cost you. Just don't forget to plug the fans back in when you're done.

to secure it down, giving each corner a few turns at a time. This way, the drop of thermal paste will spread out equally under the mounting pressure. And that's it; plug the fans or AIO pump back in, and you're good to go.

›› However, your CPU isn't the only component that uses thermal paste—your graphics card does too. Unfortunately, this process isn't quite as painless. It's easy to remove your graphics card from your system, but removing its cooler can be a tedious process that varies from card to card, and the GPU itself doesn't have a protective heatspreader like your CPU does, meaning you have to be extra careful not to over-apply thermal paste.

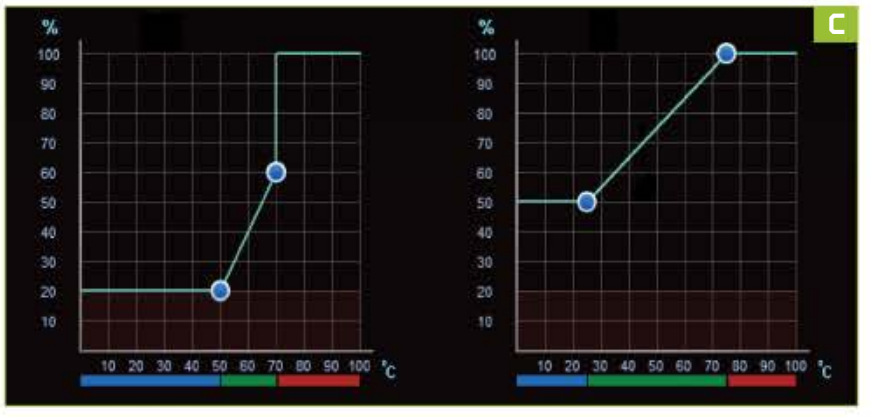
›› Identify which screws you need to remove from the backplate, and carefully pry the card apart, before following a similar process as above. We'll understand if you want to skip the graphics card, but if you're willing to go down this route, do make sure that your thermal paste is non-conductive, and make sure not to lose any thermal pads from the cooler in the process during disassembly (they typically cover the memory chips and VRMs on the card).

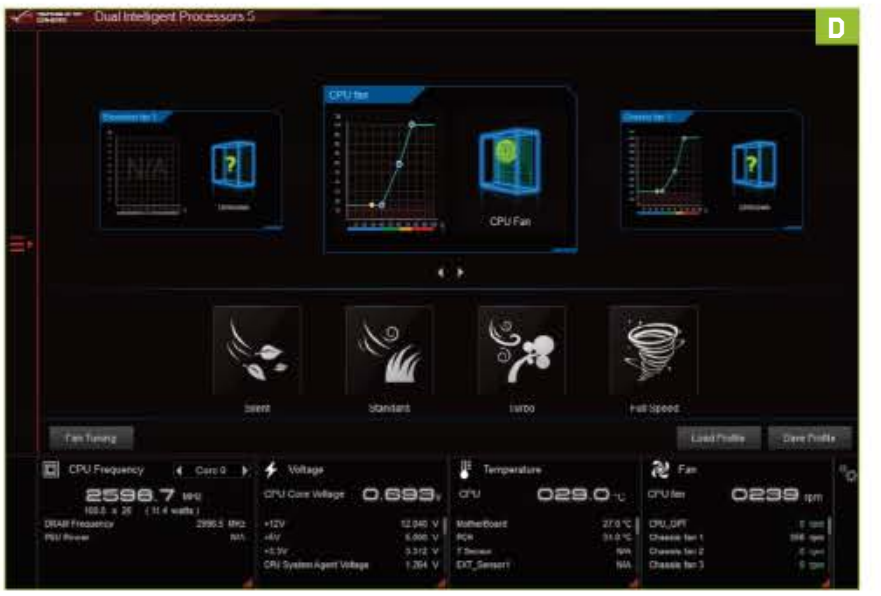
3 OPTIMIZING FAN CURVES

Chances are that your system is already much quieter than it was when you started, but we can drop the volume on your PC even more. When it comes to your system's temperatures, lower is always better, but it isn't always necessary. Most CPUs and GPUs can safely run at a temperature of up to 90 C, with a rare few running at even higher temperatures than that. It's worthwhile just double-checking online how hot your CPU and GPU can run at without problems.

›› Given that knowledge, there are a few routes you can take to optimize the fan curves of your system, in turn reducing noise, so you'll want to put some thought into what you want to achieve. You can opt for curves that prioritize silence across all loads, set the system up to run silently when idle but ramp up when under load, or you can have it always set up for maximum cooling—albeit at the cost of increased noise.

›› Of course, the last option is hardly ever preferable, but there are good arguments for either of the first two, or any curve in between, depending on your preferences and goals.





›› For Asus motherboards, open the Fan Xpert 4 tool. ASRock uses OC Tuner, while Gigabyte uses Smart Fan 5, and so on [**Image C**]. Each vendor will have its own tool, and it's also possible that you have an external fan controller from NZXT or another manufacturer. For your graphics card, use MSI Afterburner.

4 FAN CURVE DEEP DIVE

Optimizing your fan curves is essentially a matter of dictating how fast your fans will spin at different temperatures. Therefore, if your priority is silence over temperatures, you can set the fans to remain at low speeds, or even stay off until your system gets close to its maximum temperature, at which point you want to set the fan speeds to ramp up quickly. Conversely, if your priority is performance over noise, you can set the fans to speed up as soon as temperatures climb above idle.

›› Many tools have built-in profiles you can use too. Simply play around with the possibilities until you are happy with the results [**Image D**]. Idle temperatures are easy to reach: Do nothing and run nothing. For load temperatures, it's good to run a game or a synthetic test, such as Prime95 to load up the CPU, and FurMark for the GPU. Each system will respond differently to adjustments. In a system with an abundance of cooling power, fans may not need to surpass 50 percent to cool the system adequately, while more limited systems may have to work harder to keep your parts cool. And that's it. Make sure you're patient and have fun, and hopefully with a bit of elbow grease you'll end up with a far cooler and quieter system.

PREVENT ANNOYING FAN REVVING

Some motherboards and fan controllers give the option of adjusting fan spin-up or spin-down times. If you're noticing that your fans seem to rev on and off, this is often due to very brief increases in CPU loads (and thus temperatures). Setting the spin-up and spin-down times to a second or two can prevent this issue by giving the controller a moment to wait before raising or reducing fan speeds upon thermal changes, preventing unwanted noise bursts. However, only use this feature on bigger coolers that have more thermal capacity to catch the energy from the thermal spikes.

Start (& Secure) your own WordPress Blog

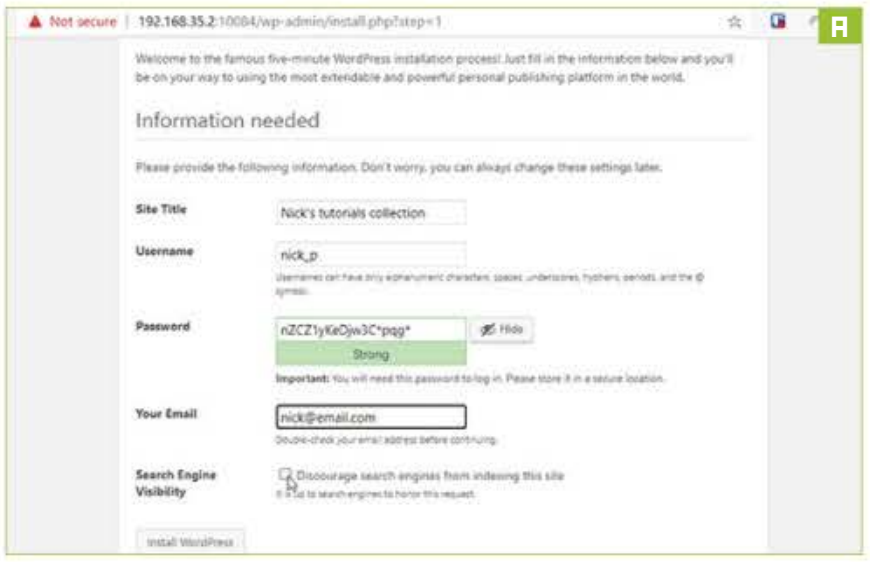
YOU'LL NEED THIS

WORDPRESS SERVER
Any reputable web host will do, or you can host it yourself on your own server.

ONE OF THE SIMPLEST WAYS to get yourself a website is through WordPress. This free and open-source platform is the world's most popular, and it's easy to see why. Although it started out as a blogging tool, it has since expanded to become capable of handling everything from personal websites to online shops.

In the first of this new series on building a WordPress site, we're going to start at the beginning by getting your site installed, set-up, secured, and ready for action. While the simplest way to set up WordPress is through signing up for a free account at www.wordpress.com, we're focusing on self-hosted solutions, whether through a third-party web-hosting platform like GoDaddy or Bluehost, or directly from your PC. The boxout opposite reveals what to look for in a web host, but if you already have web-server capabilities via a server, you can use that too (or simply use your PC to host a locally stored site for personal use or to learn the ropes).

Future tutorials will look at mastering the core skills for blogging, and look at ways you can change your WordPress site to suit your specific needs through tweaks, themes, and plugins. Let us know if there's anything specific you'd like us to cover! **–NICK PEERS**


A
Not secure | 192.168.35.2:10084/wp-admin/install.php?step=1
Welcome to the famous five-minute WordPress installation process! Just fill in the information below and you'll be on your way to using the most extendable and powerful personal publishing platform in the world.
Information needed
Please provide the following information. Don't worry, you can always change these settings later.
Site Title
Nick's tutorials collection
Username
nick_p
Password
nZCZ1yKeOjw3C*pqg*
Hide
Strong
Important: You will need this password to log in. Please store it in a secure location.
Your Email
nick@email.com
Search Engine Visibility
Discourage search engines from indexing this site
Install WordPress

1 FUSS-FREE INSTALLATION

The latest version of WordPress can be installed on any server running minimum versions of PHP 7.3 plus one of MySQL 5.6 or MariaDB 10.1. Most web hosts should have these prerequisites in place—check its tools (such as Fantastico) for an option to install WordPress. If one doesn't exist, follow the instructions at https://wordpress.org/support/article/how-to-install-wordpress/ to install it manually.

›› Synology users should install WordPress through their NAS's app store, but QNAP users should install it through Container Station for a more up-to-date version—search for WordPress, and then install the recommended App version, which essentially creates two linked containers (a database and then WordPress).

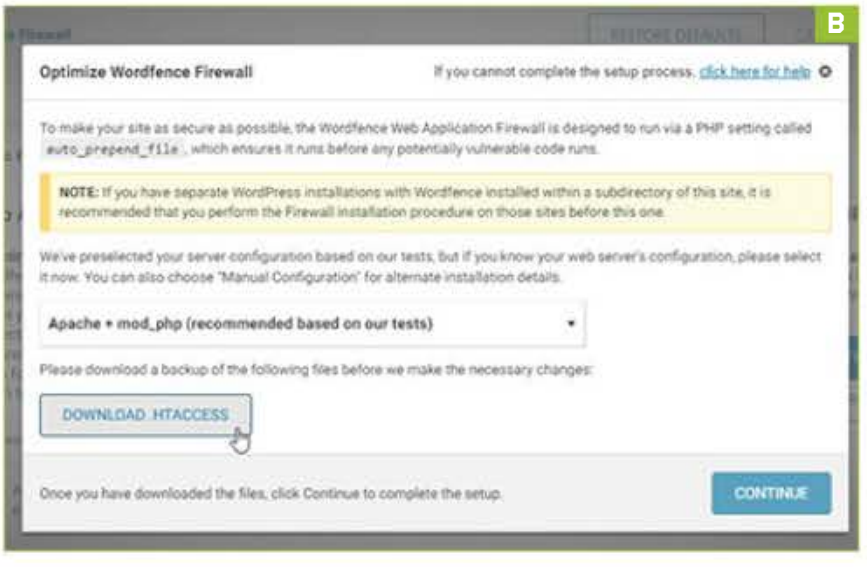
›› If you are planning on installing WordPress on an Ubuntu server, then you will need an Apache 2 web server (see https://ubuntu.com/tutorials/install-and-configure-apache). Once that is in place, follow the tutorial at https://ubuntu.com/tutorials/install-and-configure-wordpress#1-overview—it's designed for Ubuntu 16.04 or later, but it should work fine in other versions too.

›› Finally, if you want to install a local-only WordPress installation in Windows without making use of the Windows Subsystem for Linux (WSL), then visit https://bit.ly/MPCaugwordpress for a guide to setting up a simple web-based server using WAMP and WordPress.

2 INITIAL STEPS

Administration of your new WordPress installation is done through your web browser. If you've set up your WordPress install through a web host, click the link to open it in a new tab; if you've set it up locally, you'll need to open your web browser and navigate to http://192.168.x.y:12345, substituting "192.168.x.y" with your server's IP address and "12345" with the required port number (such as 10084 for QNAP Container Station users).

›› You should find yourself presented with a screen asking you to select your language. The following page [**Image A**] will ask you to name your site, then create a master user for logging in and administering it. Avoid the use of "admin" here and protect it with a strong password (either use the one generated for you—store it in your password manager—or enter your own, with a minimum of 14 characters). Enter your email address to receive alerts, and decide if you want to discourage search engines from making your site more visible to others. Finally, click "Install WordPress."


B
Optimize Wordfence Firewall
If you cannot complete the setup process, click here for help
To make your site as secure as possible, the Wordfence Web Application Firewall is designed to run via a PHP setting called auto_prepend_file, which ensures it runs before any potentially vulnerable code runs.
NOTE: If you have separate WordPress installations with Wordfence installed within a subdirectory of this site, it is recommended that you perform the Firewall installation procedure on those sites before this one.
We've preselected your server configuration based on our tests, but if you know your web server's configuration, please select it now. You can also choose "Manual Configuration" for alternate installation details.
Apache + mod_php (recommended based on our tests)
Please download a backup of the following files before we make the necessary changes:
DOWNLOAD .HTACCESS
Once you have downloaded the files, click Continue to complete the setup.
CONTINUE

© WORDPRESS

3 LOG IN AND BROWSE

Once installed, you'll be invited to log in using the credentials you've just created. This will take you to the main WordPress Dashboard. This homepage presents information via a series of customizable widgets. On the left-hand side of the screen is the menu—roll your mouse over an item and a series of sub-menus appears. Click one, and the main view changes to that screen. Return to the Dashboard at any time by clicking its entry.

4 UPDATE YOUR INSTALLATION

WordPress sites have become increasingly susceptible to hacking, so let's add some essential layers of protection while you're here. Start by checking for any updates—they'll be clearly listed under "Updates" in the left-hand menu. Click this to review what's available: Core updates are at the top, followed by plugins and themes.

›› Start by installing any core updates, then check the "Select all" box next to plugins before clicking "Update Plugins." Once done, return to "WordPress Updates" via the link, and repeat the process for themes.

5 INSTALL A FIREWALL

Keeping hackers at bay requires you to install several free plugins for your WordPress installation. Navigate to "Plugins" and click "Add New." Type "wordfence" into the search box and click "Install Now" next to "WordFence Security—Firewall & Malware Scan." Once installed, click "Activate." You'll see a new "WordFence" entry appear in the left-hand menu.

›› Go through the setup wizard, clicking "Continue" followed by "No Thanks"—the free version has all the functionality you need. Now click "WordFence" in the left-hand menu to view the plugin's own dashboard, providing a summary of the protection offered. A list of sub-menus appears on the left; under "Firewall" select "All Firewall Options" and click "Optimize the WordFence Firewall." Take a backup of your HTACCESS file, and click "Continue" [**Image B**] followed by "Close." Leave the firewall in learning mode for a week—it will then fully enable after this date.

›› WordFence also offers two-factor authentication via its "Login Security" menu to protect your WordPress account in case your login details are ever compromised. After enabling the feature, test it by logging out and back in, then return to "Login Security" and select the "Settings" tab, where you'll find an option to "Allow remembering device for 30 days." This means you can speed-up logins on browsers and devices you've logged into using 2FA by bypassing the prompt.

NEXT ISSUE: COMPOSING POSTS AND PAGES.

6 CLOSE THE GAPS

Go back to "Plugins → Add New" to install "All In One WP Security & Firewall," a 100 percent free plugin from Tips and Tricks HQ that contains loads of extra security tweaks to help ensure that your account remains secure. Once activated, the tool appears in the left-hand menu bar; click it to view its own dashboard, and be sure to enable the "Login Lockdown" and "File Permission" features under "Critical Feature Status" (leave the firewall disabled, as WordFence has that covered [**Image C**] . Check out the tutorial from 2018's February issue if you want a more in-depth look at its other features.

7 FORCE SECURE BROWSING

If your site is going to be publicly accessible from the web, you should ensure that all connections to it are made through the secure HTTPS protocol, to protect you against malicious scripts, as well as any information shared by visitors (or customers, should you set up an online shop).

›› You'll need an SSL certificate to secure the connection—unless you plan to make money from your site, you should be fine with a free Lets Encrypt certificate, which expires (and renews) every three months. Most hosting providers should offer this as a free option; check out our tutorials on setting up a reverse proxy with SSL in our January and February 2020 issues, if you're hosting the site yourself.

›› Once set up, install the "Really Simple SSL" plugin, which will automatically redirect all site requests so that they use the HTTPS protocol.

SHARED VERSUS WORDPRESS HOSTING

Many web-hosting providers offer a big range of hosting options, including dedicated WordPress packages. These often appear to be the logical choice for those looking for a fuss-free setup, but don't rush to commit: Take the time to compare these with the host's other packages (typically known as Shared, Linux, or Windows) and you may decide a more general package is better, largely because they support a range of applications—including WordPress but also options like Drupal and Joomla.

Key things to look for when comparing packages are: How many websites and/or subdomains do they support? Unlimited gives you the flexibility to add more WordPress sites or experiment with other packages. How much storage space is offered? Are there any bandwidth limits? How many databases does it support? (Most apps require at least one database.) Do you get a domain name included?

Higher-end packages also come with the promise of being backed up by more powerful hardware and free SSL certificates for additional security.

Look out for pricing—paying on a month-by-month basis is more expensive but more flexible. Many offer introductory discounts before the price jumps. Also check that added extras like SSL certificates and domains remain part of the package after the first year.

For a comparison of some of the best hosting packages offering WordPress packages, see www.techradar.com/news/best-wordpress-hosting-providers.

Customize the Desktop with Rainmeter

YOU'LL NEED THIS

RAINMETER
www.rainmeter.net

WINDOWS 7 OR LATER
Preferably use Windows 10 as it's still supported by Microsoft.

THE DEFAULT WINDOWS DESKTOP customization experience is fine, but not much more. You can change your wallpaper, adjust window accent colors, and switch up your lock screen—and that's about it. If you want more power to change up your computer's style, you will likely be disappointed with the results.

That all changes with Rainmeter. This lets you install various "skins" on Windows, all of which can add new flavors of visual flair to your desktop. These range from small widgets showing the time and weather to full-blown overhaul suites with moveable items, redesigned taskbars, and custom shortcut icons.

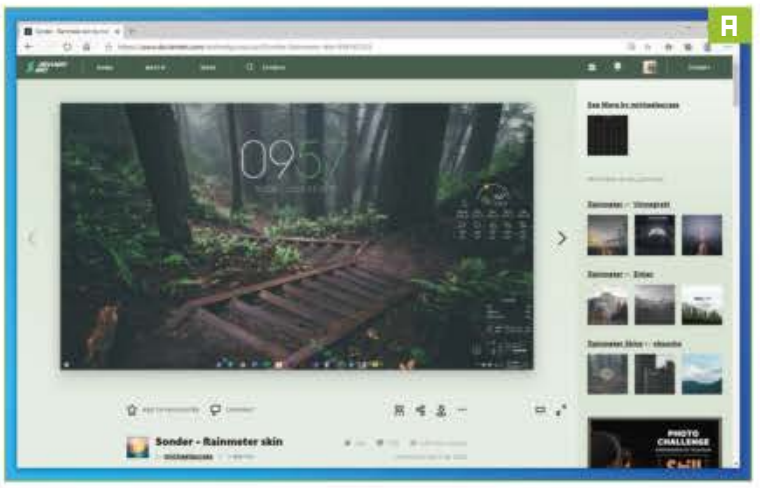
You can even build your own skins if you have a bit of coding knowledge. We will not cover that in detail today, but it is an area to explore further if it feels like your sort of thing. The good news for everyone else, though, is that Rainmeter requires no coding knowledge whatsoever, and you can easily customize most skins to your heart's content with a few simple clicks. **–ALEX BLAKE**

1 GETTING STARTED WITH RAINMETER

Head to www.rainmeter.net and download the program's installer, then follow the on-screen instructions to set it up on your computer. You can either choose the final release or the latest beta—betas are stable and have the latest bug fixes, but they may occasionally have features removed before they become finalized.

›› Once it's installed, Rainmeter will show a few basic widgets (known as "skins") on your desktop—the time and date, your PC's component statuses, and more. It will also present you with a welcome splash screen. These are all part of a pre-installed suite called Illustro. In the Windows Notification Area, right-click the Rainmeter icon, then click "Skins → illustro → Google → Google.ini." This will place a Google search box on your desktop, which you can move around wherever you like. To remove it, right-click the widget, then click "Unload skin." This principle applies to all skins.

›› You can move each skin to wherever you want, and it will remain there when you next restart your computer. To move more than one skin at once, hold Ctrl and Alt, then click on the elements you want to move; they will turn a different color to show they are selected. Now just drag one, and the others will move with it. Click anywhere on the screen to deselect them.

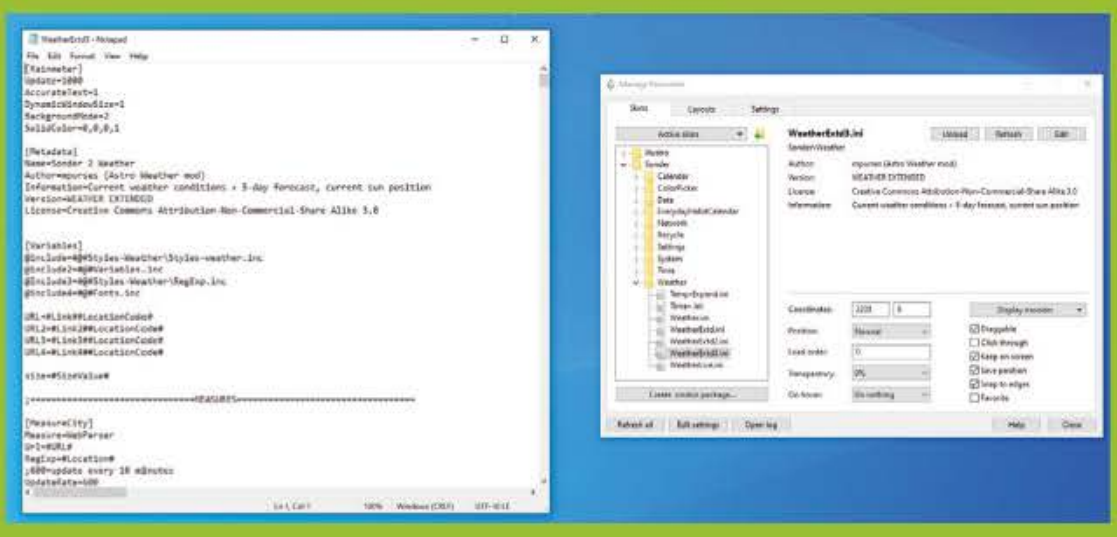


MAKING A SKIN

If you want to create your own skin—or make some more extensive edits to someone else's—you will want to get to grips with the Lua coding language and the elements that are used to create Rainmeter skins.

Each skin is comprised of various parts. "Measures" read information from your computer (such as its GPU temperature), a website, text file, or other external source. "Meters," on the other hand, are used to create visuals, including charts, images, buttons, and more. To make your skin work with other skins or apps, you will need to use commands called "bangs," while you can customize things like a skin's colors or position using text strings that are called "variables."

These are the basic building blocks of Rainmeter skins. The Rainmeter website has an excellent, extensive manual that will walk you through every step of creating your own skin. It also has a wealth of handy tips and tricks, as well as a forum that's full of helpful topics and discussions.



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THE SONDER RAINMETER SUITE

1. SKIN SETTINGS
The Sonder skin has its own settings panel, from which you can customize the skin appearance. Not all skins that are available come with a settings panel like this one, though.

2. TIME AND DATE
Sonder adds a large time and date display, which is much more convenient than the tiny clock in the corner of the Windows 10 taskbar.

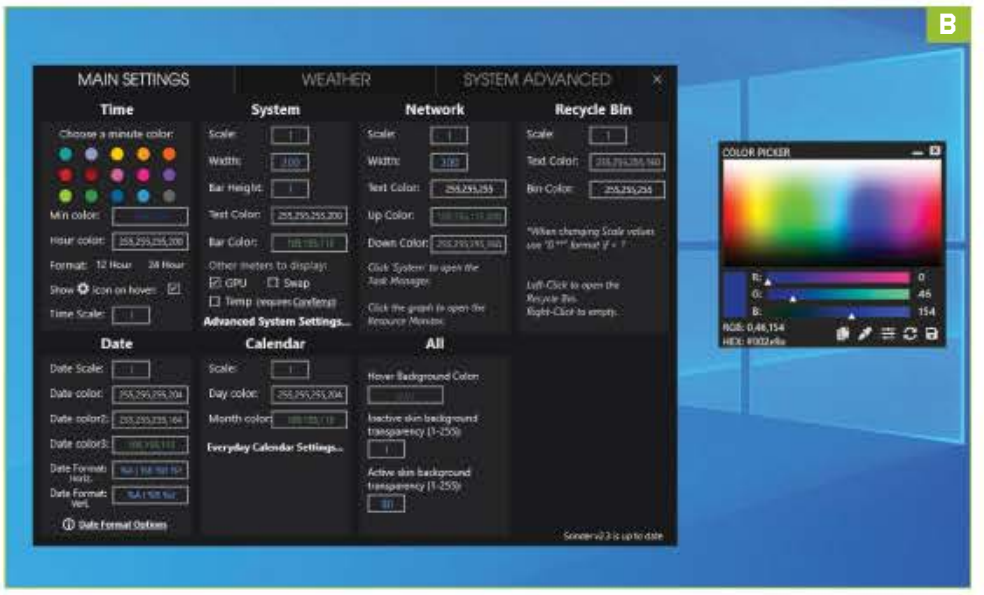
3. COLOR PICKER
Adjust the colors of various elements using a color picker. Easy customization is something to look for in a skin suite.

4. VARIANTS
Check to see if your chosen suite offers variants for each skin element. If you do not like the default option, you will be able to select something else from the choice that's offered.

5. EXTRA SKIN WIDGETS
Sonder also provides plenty of extra skins to add to your desktop. Check what your chosen suite offers, as each one will vary.

2 FINDING MORE ADVANCED SKINS

The Illustro skin does a decent job as a basic skin explainer, but it would be a shame to stop there. Rainmeter also has an enormous range of user-created skins available, many of which are truly breath-taking. In this example, we will make use of the Sonder skin.



» Head to the official Rainmeter DeviantArt page at www.deviantart.com/rainmeter/gallery. DeviantArt is one of the largest artistic communities on the internet and houses a curated selection of excellent Rainmeter skins. At the link above, click "Skins," then navigate to the entry titled "Sonder—Rainmeter skin" [**Image A**]. Under the main image, click the download button (you'll need a free DeviantArt account), and save the skin.

» Double-click on the RMSKIN file to launch the installer, then follow the on-screen instructions. When it finishes, you will see a settings box, as well as elements such as a large time display, your system details (such as CPU usage), a Performance Monitor icon, and more.

3 MAKE IT YOURS

Let's start customizing our widgets. Move each element to where you want it on the screen. Rainmeter remembers their positions so you will not have to keep moving them. Next, right-click the weather forecast and click "Variants." Here you will see several different options; click "WeatherExtd2.ini" and the weather widget changes to a more horizontal layout. Try this with each of the other widgets.

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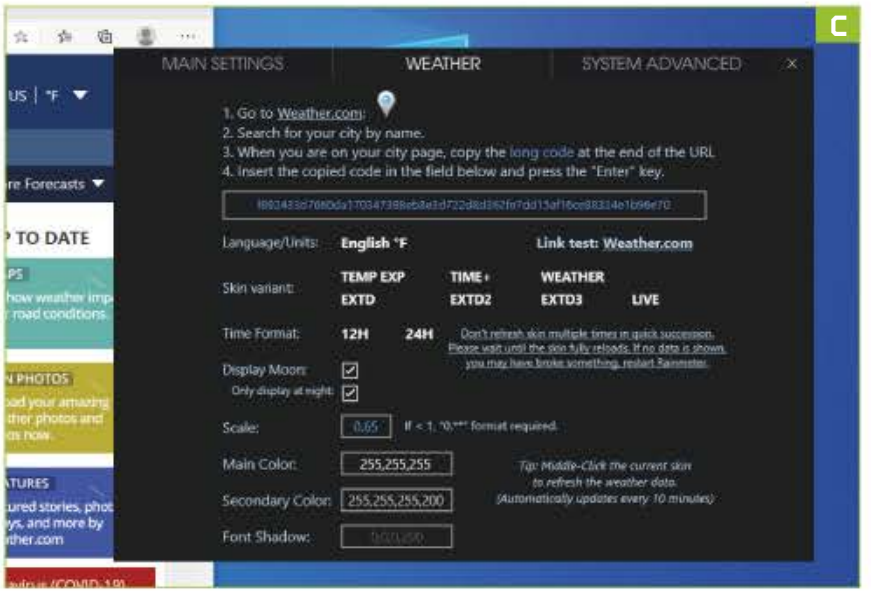
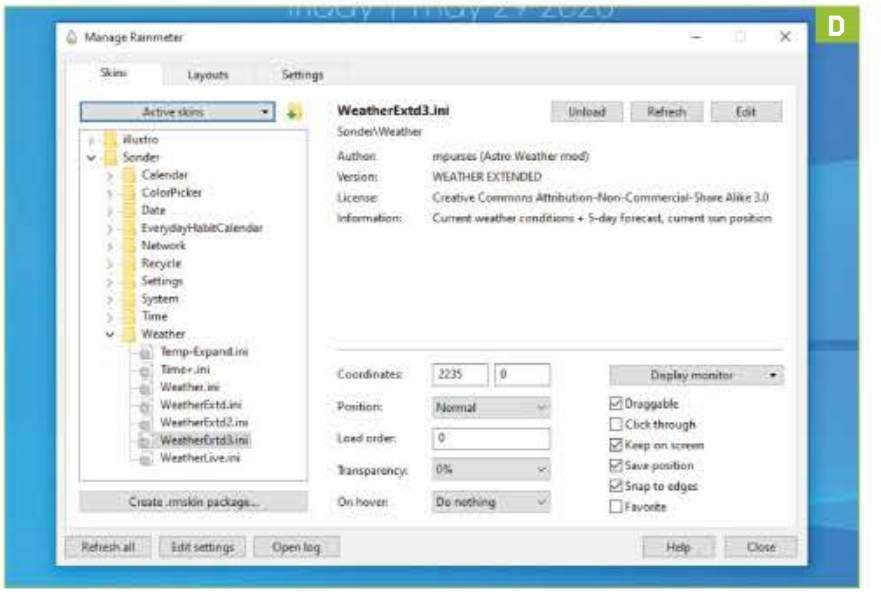




» Next, go to the settings box (if you have closed it, hover over the time and date skin, then click the cog icon). On the "Main Settings" tab under the "Time" heading, choose a new color for the clock's minute display. By default it is dark green, but this might not match your wallpaper. We have chosen a dark blue to go with our Windows background picture [**Image B**]. You can change everything, from the size of each widget to the colors it uses and the date formats displayed.

» Now click the "Weather" tab. It is no use getting weather for Houston when you are in New York City, for instance, so you will want to make sure your weather is relevant to your location. Rainmeter uses https://weather.com to get its forecasts; head there and search for your city, copy the long code at the end of its web address, then paste it into the box on the "Weather Settings" tab and press Return [**Image C**].

» The "System Advanced" tab lets you customize the info you see on your hardware components. You will get the most benefit from this if you use the "System-Advanced.ini" variant, which displays more detailed information. Part of its functionality relies on the HWInfo app, although Sonder still works without it—you will just get more specific data with this installed.

4 MANAGING A RAINMETER SKIN

An important aspect of Rainmeter is its "Manage" screen. This enables you to control each skin and widget in depth. To access it, right-click the Rainmeter icon in the Windows 10 Notification Area and click "Manage," or left-click the icon once.

» Click the "Active skins" drop-down box, then click "Sonder\SonderWeather\WeatherExtd2.ini." This will load the settings for the weather widget [**Image D**].

» If you want to prevent the skin from being accidentally moved, untick the "Draggable" checkbox. "Click through" enables you to click any element sitting underneath the widget, such as a file on your desktop. To aid with positioning, make sure "Keep on screen," "Snap to edges," and "Save position" are all checked. Alternatively, deselect the first two to move your skins exactly where you want them, without having them snap to the edges of your screen or each other.

» To the left of these options are a few more visual and positioning options. You can use the "Coordinates" boxes to get some fine-grained control over where your widgets sit on your screen. The "Position" drop-down box determines whether the skin sits on top of other windows at all times, while you can also decide how transparent it is and whether it fades in or out when you hover your mouse over it.

» Once you have finished with these controls and options, you should have a perfectly customized Windows 10 desktop that is tailored to your needs. The Rainmeter developers encourage users to experiment with skins and adjust them as needed, so you could always tinker with them even more if you so desire (see the boxout "Making a Skin" for more information).

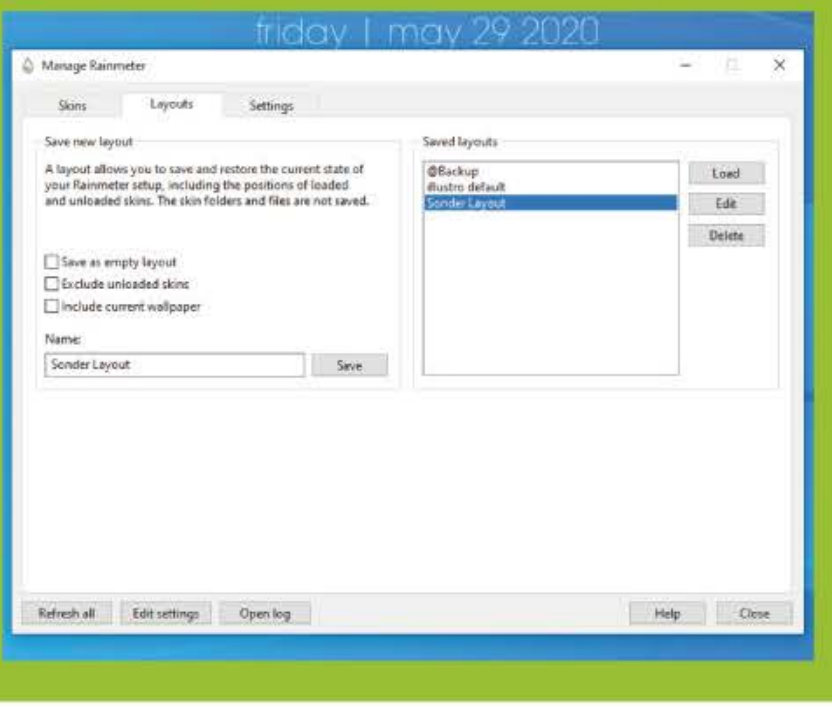
SAVING YOUR SKIN

Rainmeter has a couple of different ways to save and export your skins, but you will need to know the differences to ensure your files are safely backed up.

The first is your skin layout, which saves the current positions and settings of your skins. Open the program's "Manage" panel, then click the "Layouts" tab. Click the name of the skin you want to save on the right, then click "Save."

Note that layouts do not save any of the files you use in your skin (such as images), nor any of the skin's folders. To back these up, you can copy the skin's folder from "Documents → Rainmeter → Skins" to a safe location.

Alternatively, you can export the skin as a RMSKIN file. This will include everything needed for the skin to run, including its files. Open the "Manage" window, click your skin's name, then click "Create .rmskin package" and follow the on-screen instructions. When you are finished, safe the RMSKIN file to a backup location.



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BUILD IT

CHRISTIAN GUYTON, STAFF WRITER

A Sound Plan

This month, we're building an audio-recording PC to perfectly complement any home studio

LENGTH OF TIME: **1-2 HOURS** | LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

IN THEORY, a good PC for music or audio FX editing in a studio environment needs to do two things well. The first, of course, is audio encoding and handling. With recent advancements in motherboards, it might be possible to cover this base with just a high-end mobo, since virtually all modern mobos come equipped with on-board audio—the equivalent of a built-in sound card. Alternatively, you could go ahead and opt for a dedicated sound card, which is likely to provide you with better performance, or better yet an external DAC.

The other thing you want is silence. Background noise can spell doom for the sound quality in any live-recording studio, and the hum of fans inside a system can certainly be loud enough to disturb your sonic equilibrium. Low-RPM fans, along with a quiet cooler and PSU, are therefore a necessity. Manual fan control via your case is also a good idea, making it a cinch to drop the system noise to a minimum when the mics go live.

So we have two core tenets to abide by for our build this issue. Of course, a sound-studio system should also be a competent workstation PC in general, so we need a decent processor along with a discrete GPU, since using integrated graphics would put more strain on the processor, and we want this system to run cool so our fans can stick to lower speeds. Lastly, we want plenty of storage for all those chunky audio files.

This is certainly an interesting machine to plan and build, as we're having to make use of what we can get hold of during the coronavirus lockdown, but we feel good about the choices we've made.

AUDIO READY

SOME WILL ARGUE that sound cards are obsolete in the present day, and they're right—mostly. If you're only using your PC for generic office work or entertainment, you can probably get away with just using your motherboard's on-board sound. If you work with audio professionally, though, it's a different story. A motherboard has limited space to dedicate solely to audio, while a discrete or external sound card has a lot more room to work with. To that end, we've chosen the Creative Sound BlasterX AE-5 Plus.

Sitting in the neighboring expansion slot is the GPU, a Gigabyte GeForce GTX 1650 4GB, which should be able to comfortably handle sound-editing software UIs running across dual monitors. The motherboard that hosts these two cards is also from Gigabyte: The affordable Z490 UD AC. Since we're using a separate sound card, we don't need a pricey mobo with amazing on-board audio.

For the processor, we've got our hands on a shiny new Intel Core i5-10600K. Hyper-Threading gives it 12 threads from its six cores, and it has integrated graphics to fall back on if your GPU fails or you decide to upgrade. With a boost frequency of 4.8GHz, it's perfectly equipped for all but the most intensive professional audio work. 16GB of Corsair Vengeance LPX memory supports it, and we're keeping it cool with Noctua's NH-U12A air cooler.

For the drive, we've got a 250GB Crucial MX500 SSD to use as a boot drive and primary storage, backed up by 1TB of HDD storage in the form of Western Digital's 7200rpm WD_Blue drive. Power is handled by a 550W be quiet! Straight Power 11. This doesn't leave much upgrade overhead when it comes to wattage, but the Straight Power 11 is rated at 80+ Platinum and runs quietly. We're also going with be quiet! for the case, with the Silent Base 801. We loved the 601, so hopefully this will be a pleasant experience too.

INGREDIENTS

PART		STREET PRICE
Case	be quiet! Silent Base 801	$160
Motherboard	Gigabyte Z490 UD AC	$170
CPU	Intel Core i5-10600K	$262
CPU Cooler	Noctua NH-U12A Black	$100
Memory	16GB (2x8GB) Corsair Vengeance LPX DDR4-2666	$68
GPU	Gigabyte GeForce GTX 1650 OC 4G Windforce	$160
Sound Card	Creative Sound BlasterX AE-5 Plus	$150
PSU	550W be quiet! Straight Power 11 80+ Platinum	$120
SSD	Crucial MX500 250GB	$50
HDD	WD_Blue 1TB	$44
OS	Windows 10 Home 64-bit	$100
Total		$1,384

1

ALL YOUR BASE

AS TRADITION DICTATES, we begin with a case stripdown. Thankfully, the Silent Base 801 is very easy to work with; the sound-damping side panels lift off easily after being released with a simple button clasp. The front panel is also simple to remove, but since we'll be using the included case fans, there's no need to do so. For now, set both side panels aside, along with the accessories box. Even with the PSU shroud at the bottom, there's plenty of space to work with inside this case. It's possible to invert the layout, but we're not going to mess about with that.

Before moving on, you may also want to remove the PSU bracket and some of the expansion card blanking plates at the rear of the case. Starting from the top, with the case upright, it's the second, third, and fifth plates that need removing. You can do this later, of course, but doing it now saves you from fiddling around with the case when you're trying to install your components.

2

SOFT AND SILENT

THE SILENT BASE 801 comes with three case fans, and we'll be leaving all of them as they come. These are be quiet!'s 140mm Pure Wings 2 fans, which use textured fan blades to optimize airflow while minimizing noise. Behind the motherboard mounting plate inside the case is a small fan controller, which enables you to hook up all three fans to the same manual switch on the front I/O. If your case doesn't come with these pre-connected, plug them in and route the cables neatly ahead of time, considering in advance where your power and I/O cables will go. There's plenty of room and cable-tying spots to neatly bundle excess cable lengths inside. If your build does end up looking a bit messy, the metal blackout panels will conceal your cables as well as your shame.

3 DUE PROCESS(OR)

THE "UD" IN THIS motherboard's name stands for "Ultra Durable," so we hope it'll last for a while. It's a sensibly priced Z490 board, not bringing any exciting USP to the table but pairing well with the 10th-gen Core i5 processor we're using. It also has two M.2 SSD slots for easy future storage expansion, and comes with QFlash Plus, which makes BIOS updates a breeze. Installing the processor is easy: Release and raise the metal retention arm on the CPU socket, open up the bracket and drop the chip into place once it is aligned correctly. The plastic cover should pop off once you lower the bracket back into place and secure the retention arm.

4 SHIELDS ENGAGED

MAKE SURE THE REAR I/O shield is securely in place. It should come already attached to the motherboard, but this is a somewhat basic perforated metal plate, so be sure to double-check that none of the filaments are poking inside the ports if you bought your board pre-owned. Be careful when handling this, though: It's cheap steel, prone to grubby fingerprint marks that will be a pain to clean off. There's nothing much fancy going on back here, just plenty of standard USB ports for your connecting pleasure. We would've liked to splash out on USB-C or even Thunderbolt 3 connectivity, but ultimately it wasn't worth the associated price hike. There is, however, the two ports necessary for Intel dual-band Wi-Fi, should you need it.

7 SOUNDING IT OUT

SETTING UP THE CREATIVE SOUND card is a relatively straightforward process—in this build, anyway. For no discernible reason, the AE-5 Plus has support for RGB lighting strips, but since the 801 case is windowless we're going to go without. Setting that up also requires use of a Molex cable, and we'd like to keep this build's interior as trim as possible. Simply plug the sound card into the lower PCIe expansion slot as shown in the image, and secure it to the backplate using the screw that previously held that blanking plate in position. If you're only accustomed to PCIe x16 graphics cards, don't worry: Even though the slot is much bigger than the card's connector, it'll still slot into place perfectly.

8 NO CABLES ALLOWED

NEXT UP IS GRAPHICS, the GTX 1650 slotting in neatly beside the sound card. Be careful: This 1650 is a bit flimsy, and you don't want to accidentally damage the plastic fans or casing during installation. Check that the clasp at the end of the PCIe slot has fastened correctly, then screw the GPU down at the two available points on the backplate. Since this is a smaller graphics card with a lower TDP, it draws all its power directly from the PCIe slot and doesn't require any additional cables, so there's no need for the usual 8-pin PCIe power cable here. Once the GPU is secured, you're all done: A nice, simple graphics card installation.

5 MAKING A BRACKET

NOCTUA'S COOLERS are great for many reasons, not least because of their smart bracket design that makes them compatible with almost any contemporary CPU socket. The brackets can be fiddly, though, so unbox the cooler and work out which parts you need. It would be journalistic suicide to try and succinctly explain the process here, so you'd best stick to Noctua's instructions. The two upper bracket pieces that the heat sink will later be mounted on are helpfully labeled "this side up" for assembling convenience. These two pieces should curve outwards from the processor when correctly installed, as seen in the image below. Make sure all the screws are secure, but don't over-tighten them: We don't need to put this motherboard's "ultra durability" to the test.

6 MOUNTING TENSION

NEXT ONTO THE BOARD is the RAM. This Vengeance LPX memory could probably be installed by a toddler; just release the clasps on the two grey DIMM slots and push each stick into place until you hear it click. With your bracket, memory, and processor installed, it's time to mount this motherboard. Lay the case on its side (you may want to replace the right-hand side panel for this) and lower the motherboard carefully into place, lining it up over the standoffs. Ensure that the rear I/O is correctly aligned, then screw the board down using the included Phillips screws. Once you're confident that the motherboard is secure, it's on to the next step.

9 CHILLED OUT

INSTALLING THE NOCTUA NH-U12A cooler theoretically shouldn't give you too much trouble, especially given that you should have already fitted the more complicated mounting bracket. The heat sink should be positioned directly over the processor and screwed down to the bracket, but don't forget to place a small, pea-sized blob of thermal paste on that chip first. We recommend using something flat like a business card to evenly spread the paste across the top of the processor and remove any excess. Once this is done, lower the heat sink carefully onto the bracket, and affix both of the spring-loaded screws. Again, avoid over-tightening these, or you'll put too much pressure on the motherboard.

10 FAN THE HAMMER

ATTACHING THE INCLUDED all-black fan to the heat sink tower can be tricky. Attaching the fan first is not really an option as it would block access to one of the sprung screws we need to fit the heat sink in the first place. The NH-U12A comes with two delicate wire brackets, so be gentle. These brackets should hook through the holes in each corner of the fan casing, then enable you to clip the fan onto the ridged section on the side of the heat sink, with the wires slotting between the fins. Mount it on the front-facing side of the heat sink, positioned so it will direct air towards the fan at the rear of the case. If you're unsure, there should be tiny arrows on the fan casing that indicate which direction the air will be blown in. Setting it up wrong could be disastrous, as it would be working directly against the three case fans.

11 GOOD VIBES

TO MOUNT that Western Digital HDD, you'll need one of the individual drive cages that comes with the Silent Base 801. Secure the drive inside the cage with the provided screws, ensuring that the ports are accessible at the rear, then slot it through one of the modular gaps in the mounting plate from behind the motherboard. We're using the second slot from the bottom, as this allows for plenty of space, but feel free to experiment with different configurations (or simply mount it inside the fixed drive cage beneath the PSU shroud). The cage will affix to the case interior with three thumbscrews, which should leave the drive jutting out into the main cavity of the case. Using a 7200rpm HDD in a silent-running build might seem strange, but those drive cages have vibration-damping rubber grommets for minimal HDD hum.

12 CRUCIAL CONNECTION

INSTALLING OUR SSD is even easier. The mounting bracket we want for 2.5-inch SATA drives is located directly next to the fan hub, so make sure you don't have any errant wires getting in the way. The bracket secures with a single thumbscrew after being slotted into place. Remove it and use four of the included screws to attach the Crucial MX500 drive. The drive's power and SATA ports should face downwards when installed, for easier cable routing later on. In fact, you can connect those SATA cables now; you'll want to deal with the smaller, more fiddly cables before the chunkier power cables.

13 ABSOLUTE UNIT

THIS PSU IS A CONVENTIONAL ATX power brick, with a fully modular design. That's good, because we can eliminate virtually all excess cabling inside our case. Affix the mounting bracket to the power supply, then plug in the cables you'll need and feed them through the hole in the back of the case, before fitting and screwing in the PSU. Specifically, those cables are one 24-pin ATX power cable, one 8-pin CPU cable, and two multi-connector SATA accessory cables. One of those accessory cables can provide power both to the SSD and fan hub simultaneously. Before starting with power cables, get your front I/O cables plugged in. This shouldn't be too complicated given the lack of USB-C or lighting controls; plug the I/O cables into the appropriate headers on the motherboard, routing them in bundles where possible.

14 TIDYING UP

THERE'S PLENTY OF SPACE for cable management here, so don't worry. Feed your two motherboard power cables through the nearest available slot and plug them into the board, then direct any excess towards the top of the case. As for the rest of the power cables, these can be connected to the drives and fan hub before being coiled beneath the PSU shroud, secured with cable ties if desired. You can (and should) also use cable ties to secure the larger cables to the rear of the motherboard plate, ensuring that they retain their position. When you're happy that this build is as tidy as it can be, simply replace the metal side panels so they click into place, and you're ready to power this system up and get installing!

1 **The NH-U12A has support for a second fan to be mounted on the opposite side, should you decide you need some extra CPU cooling later on.**

2 **Decent GPUs that don't require additional PCIe power cabling are becoming something of a rarity these days.**

3 **Mounting drives in this case is wonderfully straightforward, and there's room for half a dozen more HDDs if that takes your fancy.**

4 **Hidden away beneath the be quiet!-branded PSU shroud, our power supply was impressively quiet throughout testing.**

SOUND, BUT NOT VISION

OKAY, we're gonna need you to mostly ignore the benchmarking table this time around, as our standard selection of benchmarks doesn't do much to illustrate the intended performance of this machine. The low data-transfer speeds are a shame, but we knew we wouldn't be getting any higher than SATA III speeds. We will draw your attention to the CPU performance in Cinebench, however, which came out strong for a mid-range Intel chip. *Total War: Warhammer II* also saw a higher score than we had expected given this system's budget GPU, but since the game is CPU-bound it does make sense.

In order to properly test this system, we downloaded PassMark's SoundCheck program, which can be used for sound-card testing (among other things). The Sound BlasterX card had no difficulty reproducing sample rates up to 128,000Hz—the maximum offered by SoundCheck—and it was able to hit that target rate with impressive accuracy even when replicating white noise. Unfortunately we didn't have a set of high-end audiophile speakers during testing, but over headphones all the audio came through beautifully crisp and clear.

In hindsight, we might've put a slightly more powerful GPU in this system, if we were to build it again. A GTX 1660 Ti or 1660 Super would have been a significant step up in terms of gaming and rendering, or we could've leapt all the way up to an RTX card to turn this into a 4K audio and video-editing powerhouse of a workstation PC. It would mean including an extra power cable for the GPU, but the case has more than enough room for that. Of course, it would also lead to a hefty jump in price, and we're quite happy with how much the system we built cost us: A studio-quality sound-editing PC for under $1,500 is a fair deal indeed.

While it's a massive, unwieldy case, the Silent Base 801 did make for an incredibly quiet machine. We may have achieved the same results with the smaller Silent Base 601 or 500, but we're very pleased with how softly this system runs. The fans are almost imperceptible even in a quiet room, and the HDD's whirr is completely muted. Having the manual fan control via the front I/O is nice, letting you pump the fans up to full speed when you start a lengthy encoding or rendering process, but even at maximum the fans aren't exactly noisy.

In terms of aesthetics, there really isn't much to see here. The windowless case is something of an oppressive, orange-accented monolith, but the clear absence of any RGB lighting or other decorative frivolities marks this system as a professional product, well-suited to a work environment. Keeping the interior tidy isn't hard, so air-dusting the guts of this case every few months should be easy.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	1,152	1,470 (28%)
CrystalDisk QD32 Sequential Read (MB/s)	3,400	561 (-84%)
CrystalDisk QD32 Sequential Write (MB/s)	1,720	517 (-70%)
Tom Clancy's Ghost Recon Wildlands (fps)	39	34 (-13%)
Total War: Warhammer II (fps)	46	30 (-35%)
Rise of the Tomb Raider (fps)	60	60 (0%)
3DMark: Fire Strike (Index)	11,101	8,003 (-28%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an AMD Ryzen 5 1600, 16GB Crucial Ballistix Sport LT @ 2666MT/s, an EVGA GeForce GTX 1060 3GB and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.

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Intel Core i5-10600K

The gaming staple finally gets Hyper-Threading

UNDOUBTEDLY the i5s of this world are the most popular of Intel's CPUs, the most sought after. These mid-range chips have often provided an astonishingly good-value proposition for those not looking to render everything at lightning speed. They have been and still are by far the go-to chip of choice for the gamer. Why's that? Well it all comes down to impressive single-core performance, balanced perfectly with power draw, thermals, and cost. Get all the gaming prowess of a Core i7 or an i9, but with 50 percent off the latter's retail price tag.

For the longest time, in Intel's world of quad-core dominance, the main difference between the Core i5 and the i7 product lines was one simple addition: Hyper-Threading. The logic at the time as far as recommendations were concerned was simple: If you used your machine as part of your work day, and multi-threaded applications were key to that, then the Core i7 was the processor to pick; if you didn't, and it was solely for gaming, the Core i5 was the best solution. For everything else there was the Core i3. Nothing really changed from its 1st to its 9th-gen architectures. Until now.

Yep, we've finally crossed that sacred threshold: Intel's latest Core i5-10600K comes with Hyper-Threading, giving you access to six cores and 12 threads. In fact, mimicking its AMD rivals, every single processor—bar the very low-end Celeron parts—in Comet Lake features Hyper-Threading as standard. So whatever the core count, you can effectively double it for better performance in applications that benefit from more threads.

So what does that mean? Well this Core i5-10600K is almost equivalent to the Core i7-8700K launched back at the end of October 2017. In single-core performance it clocks up to 4.8GHz turbo, 200MHz faster than its three-year-old predecessor. It doesn't stop there either, with a new, wider chip design (thus the new socket) and better solder TIM (thermal interface material) between the die and the integrated heatspreader. The Core i5-10600K is about 10 degrees cooler too, and cheaper at $262 instead of the Core i7-8700K's $359.

But this isn't 2017, and the landscape has evolved dramatically. Intel's biggest competition for this generation of Core i5 is AMD's Ryzen 5 3600X, and that's no slouch either. Right off the bat, support for PCIe 4.0 gives AMD the edge—certainly in terms of future-proofing—and its refined architecture and 7nm manufacturing process has helped sharpen up the low single-core IPC figures we saw when Ryzen first launched.

In our testing, things perhaps fell where you might expect: AMD's Ryzen 5 3600X held the high ground when it came to any multi-threaded task, only losing out in single-core performance. This is in part down to AMD leaning heavily into PBO to keep the turbo speeds up across all of its cores for longer, and in part due to better optimization in multi-threaded applications. Although game-changing at the time, Hyper-Threading just isn't quite as efficient as AMD's multi-threading, and it shows here. In areas where we typically see Intel shore-up victories thanks to its impressive single-core performance, AMD starts clawing back some results, with it being only five percent slower in applications such as FryRender and TechARP's x264. In games, however, the pure grunt of Intel's single-core performance and extensive optimization shines through, with a solid six to seven percent performance bump noticeable in both of our testing titles.

We're also seeing lower temperatures on our Core i5-10600K than the competition, and yet lower power-draw on Ryzen. It's a whole mixed bag. The two chips are very impressive, and very similar, but there's one caveat, and that's the price. Right now AMD's readjusted its processors to capitalize on Intel's new launch, and we're seeing the Ryzen 5 3600X available for just $205, down from the $250 it originally debuted at. It's not a huge drop, but combine that with the included cooler, and the peace of mind knowing you have PCIe 4.0 compatibility, and it certainly delivers a blow to the i5.

If you're dead set on Intel and are after a new gaming processor that you can dabble in multi-threaded apps, Intel's Core i5 still represents good-value. However, the reality is that AMD's Ryzen 5 3600X is just better for the money, and the better recommendation if you care at all about future-proofing. **–ZAK STOREY**

BENCHMARKS

	Intel Core i5-10600K	AMD Ryzen 5 3600X
Cinebench R15 Single (Index)	**210**	198
Cinebench R15 Multi (Index)	1,491	**1,659**
Tech ARP's X264 (avg fps)	31.14	**33.08**
Fry Render (m:s)	2:04	**1:55**
Power Draw Idle/Load (W)	63/245	**58/232**
Total War: Warhammer II @ 1080p (fps)	**81**	76
Ghost Recon Wildlands (fps)	**58**	55
Maximum Overclock (GHz@V)	**5.2 @ 1.35V**	4.2 @ 1.4V

Best scores in bold. Our test bed consists of an MSI MEG Z490 Ace, 32GB of Corsair Vengeance RGB Pro DDR4 @ 3200, and an Nvidia GeForce GTX 1080. All games were tested at 1080p on the highest graphical profile, with average fps noted.

VERDICT **8**

Intel Core i5-10600K

HYPERDRIVE Hyper-Threading as standard, good value, great gaming performance, decent multi-threaded performance.

SOLAR SAIL Ryzen 5 still better value, doesn't support PCIe 4.0.

$262 www.intel.com

SPECIFICATIONS

Cores / Threads	6 / 12
Base / Turbo Clock	4.1 / 4.8 GHz
Architecture	Comet Lake
Lithography	14nm++
Memory Support	Dual Channel @ 2666 MHz
PCIe Support	x16 PCIe 3.0
Integrated Graphics	Intel UHD Graphics 630
TDP	125W

Okay, we'll stop with the 14nm+++++ jokes now...

The Nitro 7's black-and-red aesthetics will no doubt prove divisive.

Acer Nitro 7

Laptop gaming without the hefty price tag

THE NITRO 7 isn't immediately exciting. It looks exactly how we imagine a "gaming laptop" should look: Sturdy, with a big screen, and red keys against an all-black chassis. It's relatively well-made, but it doesn't jump out at us like some new laptops do. That's not to say we don't like it; despite its metal exterior and large screen, the Nitro 7 barely weighs five pounds, and is easy enough to slip into a shoulder bag when you're on the move.

Let's talk about that screen first. It's a standard 15.6-inch 1080p panel, with a crisp 144Hz refresh rate, ideal for twitchy shooters. The brightness and color density are good, although we wish the chunky upper and lower bezels were a bit smaller—a change that could potentially shrink the laptop's overall footprint too. The display's hinge leaves a lot to be desired, as the screen wobbles a bit whenever its position is adjusted. We'd like the entire thing to feel a bit more robust, but it doesn't quite verge into feeling cheap. This isn't a chassis to rave about, but the metal construction does look good.

The keyboard makes for a much more pleasant experience. These membrane keys have a decent amount of travel and don't shift around too much when pressed, with red key backlighting that feeds into that "gamer" aesthetic. The chassis provides plenty of space to rest your wrists while typing, but still packs a large, easy-to-use trackpad. The clicking sensation is a bit spongy, but given that any gamer worth their salt will be using a USB mouse anyway, it's not an issue.

Internally, this model's most exciting draw is the Intel Core i7-9750H processor. No, it's not one of the flashy new 10000-series CPUs, but this mobile processor is barely more than a year old and packs 12 threads thanks to Intel's hyper-threading tech. It performs admirably in CPU-intensive tasks and games, matching the previous generation's 8750H in Cinebench R15 even with half the RAM, as seen in our zero-point benchmark. Yes, this gaming laptop does only have 8GB of memory, which feels like something of a cop-out given the upgraded processor. It is upgradable up to 32GB, however.

The GPU, on the other hand, is a conventional budget offering: The GTX 1650. It's certainly a cut above integrated graphics, and should have zero problems running most games on that 1080p screen, but it may struggle with recent AAA titles. It's not going to dominate benchmarks, but it's not a bad fit for this machine, thanks to its lower power draw and heat buildup. The dual exhaust ports mean that the fans can effectively dissipate heat from the chassis, so the Nitro 7 didn't get significantly hot at any point during our testing. The benchmark figures down below might seem harsh, but bear in mind that our comparison system costs nearly twice as much.

Elsewhere, the Nitro 7 remains a mixed bag. The SSD is adequately sized at 512GB, which should be enough to store plenty of games, but the file transfer speed is unimpressive for an M.2 drive. The battery is lackluster, burning out after less than two hours of gaming at 50 percent of maximum brightness. The sound, however, is pretty great, utilizing Waves MaxxAudio technology to optimize bass and dialogue for maximum clarity. The speakers get pretty loud, too.

The last thing we'd like to touch on is connectivity. The Nitro 7 does well in terms of physical connectivity (the only key thing missing here is Thunderbolt 3 support, though there is a normal USB-C port) but sadly hasn't made the leap to Wi-Fi 6 just yet. Killer Ethernet E2500 mitigates this if you're planning on keeping the Nitro 7 in one place, at least.

It's not a mind-blowing product, but it's sensibly priced at $1,130 and we'd recommend it to anyone looking for a capable, affordable gaming laptop. If you crave high performance, you may be better off waiting for Acer's next Predator-series laptop. **–CHRISTIAN GUYTON**

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	1,030	**1,042** (1%)
CrystalDisk QD32 Sequential Read (MB/s)	**3,374**	1,747 (-48%)
CrystalDisk QD32 Sequential Write (MB/s)	**2,530**	1,449 (-42%)
3DMark: Fire Strike (Index)	**13,610**	11,830 (-13%)
Rise of the Tomb Raider (fps)	**92**	66 (-28%)
Total War: Warhammer II (fps)	**62**	44 (-29%)
Tom Clancy's Ghost Recon: Wildlands (fps)	**49**	32 (-35%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Best scores in bold. Our gaming laptop zero-point is the Acer Predator Triton 500, with an Intel Core i7-8750H, Nvidia GeForce RTX 2060 Max-Q, and 16GB of DDR4-2666. All game tests are performed at 1080p at the highest graphical profile.

VERDICT **7**

Asus Acer Nitro 7

NITROUS OXIDE CPU performance is great, 144Hz display is good, lighter than it looks.

CARBON MONOXIDE Only 8GB of RAM, flimsy screen hinge, battery life isn't great.

$1,130, www.acer.com

SPECIFICATIONS

CPU	Intel Core i7-9750H
Graphics	Nvidia GeForce GTX 1650
RAM	8GB DDR4 SDRAM
Screen	15.6-inch IPS 1080p screen @ 144Hz
Storage	512GB M.2 NVMe SSD
Ports	1x USB 3.1 Type-C, 2x USB 3.1 Type-A, 1x USB 2.0 Type-A 1x HDMI 2.0, 1 x 3.5mm audio jack, 1x RJ-45
Connectivity	Wi-Fi 5 (802.11a/b/g/n/ac), Bluetooth 5.0
Weight	5.51lbs
Size	0.9 x 10.2 x 14.3 inches

Unlimited power!

MSI MEG Z490 Ace

Intel's new chipset finally hits our lab

LET'S JUST PREFACE this by saying, yes, this is a $400 motherboard. However, we've already featured the Gigabyte Z490 Aorus Pro AX in our build this issue, and the motherboard Intel sent us with its media package is the insanely expensive Asus ROG Maximus XII Extreme, which currently clocks in at no less than $750. So weirdly this is currently our only "mid-range" motherboard, so far as it's the middle one in our office right now. How odd. That's not to say there aren't budget options out there—there's a bevy of boards below the $150 mark still harboring the Z490 chipset spec, and on top of that manufacturers have launched H470 chipset motherboards too, which are even cheaper than that. So what makes the MSI MEG Z490 Ace so special?

Well, in a similar manner to Asus's Apex series of mobos, or EVGA's Dark lineup, it's all about providing a solid overclocking platform, alongside a swathe of modern connectivity and aesthetic design appeal. Now that might not sound very appealing to the average Joe, but you've got to understand that a lot of stock processor performance relies on that same overclocking heritage. It's all about the capacity of both your cooling solution and the motherboard's power delivery. Whether that's with Ryzen's PBO and auto-overclocking features, or Intel's Turbo or TVB (Thermal Velocity Boost) frequency tech, there's now no longer a fixed max clock-speed.

Take the core i9-10900K as an example: You've got the base clock at 3.7GHz; the Turbo 2.0 frequency—what it can achieve across all cores when under load—listed at 5.1GHz; the Turbo Boost 3.0 frequency—what the processor can achieve across its four best or fastest cores in lightly threaded tasks—at 5.2GHz; and finally TVB, which takes those same two to four cores beyond Turbo 3.0's max prescribed frequency, if the processor is still under its target temperature and there's still available power budget. What that means is that every single 10th-gen processor will clock differently and behave differently across lightly threaded tasks, depending on the silicon lottery, cooling solutions, and motherboard power delivery.

ACE OF SPADES

To that end, the MSI MEG Z490 Ace comes packing a 16+1 power-phase design (16 for CPU VCore, one for the SOC), and dual eight-pin EPS power connectors. What that means is you have a perfectly balanced, mirrored power arrangement, further backed up by an Intersil digital PWM controller feeding eight Intersil phase controllers. That then goes into 16 individual 90A power stages MOSFETs, each paired with a titanium choke III. In comparison, last-gen's Z390 Ace features a 12+1 setup, with a maximum amperage of 720A, half that of the 1440A in the Z490 MEG Ace. That in part is why we've seen a new chipset and a new socket as well. Intel's clearly seen that its Comet Lake processors will pull more power and generate more heat, and has re-engineered the chipset and motherboard requirements to compensate for that.

Ultimately, what that leads to with MSI's MEG Z490 Ace is a fantastically well-equipped motherboard, not only in its connectivity but also in its capacity to deliver strong stock performance if the conditions are right. We've of course also seen improvements with the onboard connectivity, with Wi-Fi 6, 2.5G Ethernet, improved audio, support for up to three M.2 drives—all with heatsinks—a bevy of USB ports littered everywhere, and impressive memory support topping out on capacity at 128GB (4x32GB) @ 4,000MHz, or max memory frequency at 4,800MHz with 32GB (2x16GB) sticks.

If you're after a mid-ranged king of a motherboard, have $400 to spare, and don't quite mind the eccentric stylings and those copper/gold accents, then the MSI MEG Z490 Ace is a fine choice for your rig. The only caveat is it is quite expensive, especially compared to some of the perhaps better-equipped competitors at a similar price. MSI's banking on that power delivery bearing fruit, and as the platform matures and BIOS updates bring more performance, we hope so too. Is that enough to offset the price? Well we'll leave that one up to you. **–ZAK STOREY**

VERDICT 8

MSI MEG Z490 Ace

TOPGUN Impressively engineered, strong power delivery, good stock performance, vast connectivity.

MISSED THE MARK Pricey.

$400 www.msi.com

BENCHMARKS

	MSI MEG Z490 Ace	Gigabyte Z490 Aorus Pro AX
Tech ARP's X264 (fps)	**56.25**	56.20
Cinebench R15 Multi (Index)	**2,595**	**2,590**
Fry Render (m:s)	**1:15**	1:16
AIDA64 Memory Latency (ns)	**50.3**	50.3
CrystalDisk QD32 Sequential Read (MB/s)	3,312	**3,352**
CrystalDisk QD32 Sequential Write (MB/s)	**2,972**	2,961
Power Draw Idle/Load (Watts)	65 / 307	**62 / 295**
Total War: Warhammer II (fps)	**65**	**65**

Best scores are in bold. Our test bed consists of an Intel Core i9-10900K, 32GB of Corsair Dominator Platinum RGB @ 3600, an Nvidia GeForce RTX 2080 Super, and a 960GB Corsair Force MP510. Total War: Warhammer II was tested at the ultra preset @ 1440p. MSI motherboard retested on BIOS version: 7C71v122

SPECIFICATIONS

Chipset / Socket	Z490 / LGA1200
Max Memory Support	128GB (4x32GB) @ 4000MHz
Storage Support	3x M.2 PCIe 3.0, 6x SATA 6Gbps
PCIe Support	3x PCIe x16, 2x PCIe x1
Form Factor	ATX
Rear I/O	5x USB 3.2 Type A, 1x USB 3.2 Type C, 2x USB 2.0 Type A, PS/2 Combi Port, Intel Gigabit Ethernet, Realtek 2.5G Ethernet, 5.1 Audio, Optical Audio out, Wireless AX

Asus ROG Strix Go 2.4

Ready, set, go

THIS MIGHT BE ONE of the best portable gaming headsets we've ever seen. Coming with a sleek hardshell carry case, detachable mic, and 3.5mm cable, along with wireless connectivity via a small USB-C dongle, the ROG Strix Go 2.4 can connect to just about any modern device, be it a PC, smartphone, tablet, or console. Apple fans may be left out in the cold, but hey, this isn't *Maximum iMac*.

The Go uses a 2.4GHz wireless connection with twin antennas that results in virtually zero audio latency or interference. We found the sound quality to be crisp, clear, and lag-free, no matter what device we connected it to. The little black dongle is emblazoned with the Republic of Gamers logo, and comes with a USB-A adapter for use with consoles or older computers. We tested the connection on a desktop PC, a laptop, a PlayStation 4, a Nintendo Switch, and a Sony Xperia XZ2; every time, setup was as simple as turning on the headset and plugging in the dongle, even on first use.

There's no Bluetooth, so you have to use the dongle or 3.5mm cable on smartphones, which is a minor frustration. If you prefer a wired connection, a 1.2m, 3.5mm cable is included and allows for hi-res audio support. Even over the 2.4GHz connection, though, the sound quality is brilliant; airtight chambers and Asus's own 40mm drivers make for a rich and bassy soundscape—perfect for shooters and fighting games. Pinpointing an enemy sniper in *Call of Duty: Warzone* using only sound feels fantastic.

Obviously, the compact design is a major selling point here, with the whole headset folding up neatly to fit inside the included carry case. The earcups themselves are a little small, which didn't cause us any problems but could be an issue for some users (particularly anyone with ear piercings). The breathable cushioning on the ears and headband is very soft and squashy, making long gaming binges comfortable without getting sweaty.

The whole headset is very lightweight but doesn't feel flimsy, with matte black plastic forming most of the casing and a sturdier metal core inside the headband. A bi-directional boom mic extends on a flexible arm, but it can be detached and voice handled instead by a smaller omnidirectional mic hidden inside the earcup. While the arm mic is a bit better, both mics benefit from AI-assisted noise cancellation technology, which works impressively well to dull background noise by utilizing a deep-learning database to identify and silence common environmental noises.

Physical controls on the Go are a bit barebones, with just a volume wheel, multimedia control button, and wireless power switch. The button in particular feels a bit flimsy, which is annoying when you're trying to triple-click to rewind a track when listening to music. The volume "wheel" is actually a three-way switch disguised as a roller; pushing up and down adjusts volume, while clicking mutes the microphone. The headset controls all work, but using them did leave us somewhat underwhelmed.

Charging is handled by an included USB-C cable, and the port isn't shaped, so any USB-C cable should be able to charge it. When fully charged at 50 percent volume (perfectly loud for playing games in a quiet environment) with the mic in use, the headset lasted for more than eight continuous hours and nearly 21 hours across multiple sittings, with a maximum of 25 hours advertised by Asus. The clinical voice shouting "LOW BATTERY" in the ear is only terrifying the first two to four times, we promise.

If portability is what you're after, the ROG Strix Go 2.4 is a shoe-in, offering some of the best comfort and performance of the lightweight and compact gaming headsets available right now. However, if you're looking for a headset for PC gaming only, this likely won't be the way to go. The simple exterior design means that you could easily wear this headset on the commute, so multiplatform use is the name of the game; if you play games on more than one screen, then you should give the Go a go. Ahem. –CHRISTIAN GUYTON

VERDICT **8**

Asus ROG Strix Go 2.4

GO Fantastic audio quality, AI noise cancellation, multiplatform plug and play.

STOP No Bluetooth connectivity, headset controls are flimsy, earcups are on the small side.

$120, asus.com

SPECIFICATIONS

Driver Type	40mm neodymium magnet
Frequency Response	10Hz–40kHz
Sensitivity	-54dB
Design Style	Circumaural, closed back
Microphone Type	Bidirectional/ Omnidirectional Condenser
Connection Standard	2.4GHz
Battery Life	25 hours
Weight	0.64lb

Aukey KM-G6 LED Mechanical Keyboard

Click clack to reality

BEFORE WE TALK about anything else, we want to give a bit of attention to the Aukey KM-G6's box. It is, quite frankly, beautiful: A beige rectangle of recycled cardboard with simple black text stamped on the top, along with a monochromatic illustration of the keyboard itself. It looks like it arrived by falling through a time portal in the 90s, and we love it.

The keyboard inside that box looks like it sits very firmly in this century, though. Colored LEDs under each molded plastic keycap, and media controls integrated with the function keys make this a competent keyboard for modern-day use, even if it is slender on the feature side. There's no extra macro keys or volume wheels, only a standard 104-key layout with a compact plastic base. It's quite lightweight, but we wouldn't describe it as an on-the-go keyboard: A five-foot USB cable and chunky underside means you wouldn't want to throw it in a backpack.

Once you start using the KM-G6, though, the retro sensation comes flooding back. This keyboard uses Outemu Blue mechanical switches: The "clicky" variety, which provide the ultimate in tactile feedback when typing. The clatter of these keys is noisy but oddly comforting to anyone who sat in a busy office or a school computer lab in the late 90s. If the KM-G6 was colored that unsettling off-tan of 90s PC hardware, we'd be worried we were experiencing some time-shifting shenanigans.

If you already know that clicky blue key switches aren't for you, you can head off to a different review right away. The KM-G6 exemplifies this type of keyboard, making it enjoyable to type on, but the almost typewriter-like noise is bound to frustrate some users (and people in your immediate vicinity). Clicky switches aren't the most popular choice among gamers, too, but they serve to virtually eliminate any key-press ghosting—useful for games where an accidental press can tank your chances of victory.

If you do like your keys clicky, though, stick around. These Outemu Blues aren't rated for quite as many presses as their more popular Cherry counterparts, but they feel better to use, with a crisp, clear click and excellent tactile feedback on simultaneous key presses. While Cherry might be the Western industry standard, cheaper brands like Outemu and Kailh have improved significantly in recent years. The click on these new Outemu switches sounds deeper than any we've heard before, which is actually quite nice.

This isn't Aukey's first venture into keyboard production, but the company is more at home with power-related products like cables and chargers. It's certainly not a throwaway effort, though; the metal top panel and solid plastic parts all feel very durable, and the entire keyboard is also advertised as "water-resistant"—although we admit we didn't put that to the test. The basic rubber-coated USB cable is the only part that doesn't feel especially robust, but it doesn't feel flimsy either. Considering that it only costs $40, we certainly can't complain about the build quality.

The lighting is a minor disappointment, however. The promo pictures show a rainbow pattern, but the lights nestled under these keys are in fact fixed-color LEDs, arranged in six neat rows. There's no software here; you can swap between eight different preset lighting options or create your own configuration to save in one of two slots, all using keyboard shortcuts. The preset effects are nothing to write home about, either running simple animated loops or highlighting the keys used for various game genres (like highlighting WASD and the number keys for MMOs). The LEDs themselves look fine but aren't particularly bright.

Put simply, this is a keyboard for clicky connoisseurs. If those tactile switches are what you crave, check this out; otherwise, it might not be the keyboard for you. This is a good and inexpensive example of the clicky-key experience, and might be an ideal starting point for anyone wanting to change up their typing or gaming sensation. –CHRISTIAN GUYTON

VERDICT **7**

Aukey KM-G6 LED Mechanical Keyboard

CLICKY Not too expensive, wonderfully clicky Outemu Blue switches, retro stylings.

CLUNKY Lighting is unimpressive, keys are undeniably noisy, no unique features.

$40, aukey.com

SPECIFICATIONS

Switch Type	Outemu Blue Clicky Mechanical Switch
Switch Durability	50 million presses
Media Keys	Integrated w/ function keys
Connection	Single USB 2.0
Battery Life	N/A
Wrist-rest	N/A
Dimensions	5.3 x 17.0 x 1.5 inches

The quaint, hex-based worlds are the setting for this relaxing 4X game.

INDIE 4X STRATEGY

Before We Leave

Build a cosy colony, but beware of the whales

READERS OF A NERVOUS disposition may want to look over the page at the game in which you chainsaw bad guys, because despite its nonviolent nature, city and planet-builder *Before We Leave* hides a dark secret: It calls its population "peeps."

Players who can get past the twee, however, will discover a 4X game without the extermination—a 3X if you like—in which your citizens emerge from an underground bunker to revel in the sunlight of a rejuvenated world. What the disaster was that forced them down into the darkness we're not told, but judging from the artifacts left on the surface, the peeps' ancestors were once an advanced spacefaring civilization.

You start out on an island with limited resources and an old boat. Fixing this up to explore strange new lands becomes the aim, sending out colonists to the other islands to harvest more resources and discover... an old rocket. Fixing this up then becomes the aim, until you blast from the surface of your world and into a solar system where other planets lurk, ripe for colonization—and stranger things besides, including graceful, hungry space whales that appear very late in the game.

The spheres you explore are made of hexes, and you can spin them about like some kind of mad god. The population doesn't seem to mind, however, and the hex-clouds obligingly shuffle out of the way so you've always got a clear view. Each member of the population has a name and a couple of lines of descriptive text that gives them a bit of personality, and it's enjoyable to zoom in and watch them bouncing about the landscape in real time, following roads to their jobs, gathering resources, heading home at dusk, and generally getting on with things. The day/night cycle means things get a bit harder to see at night, and many of your citizens will want to go home, but this is a 24-hour economy.

As you explore, expand, and exploit, you'll eventually pepper the landscape with mines, lumber camps, and more. Each of these needs to be connected to the road network, as does every dwelling you build for your workers. This isn't unusual for the genre, but your transport network carries the seed of frustration in it, as you struggle to punch roads through narrow gaps (especially in desert landscapes, where you'll only want to build them on sandy hexes that are useless for food growing) while keeping frontage for your buildings. The fact that explorers, who seek ancient knowledge from archaeological sites, can wander across fields and mountains just makes the point—if they can, why can't miners?

The lack of any enemy to exterminate makes the game more about optimization, which the road conundrum perfectly feeds into. Fixing up the boat or rocket means gathering resources, processing them, and combining them with the fruits of the tech tree. Then you need peeps to work on the repairs while maintaining enough of a workforce to keep the economy stable.

This relaxing, cutesy, low-stakes take on the 4X does itself a disservice by keeping the space whales until so late in the game, but delivers on its promises of a combat-free way to let the hours pass in pursuit of the perfect colony. **–IAN EVENDEN**

VERDICT **7**

Before We Leave

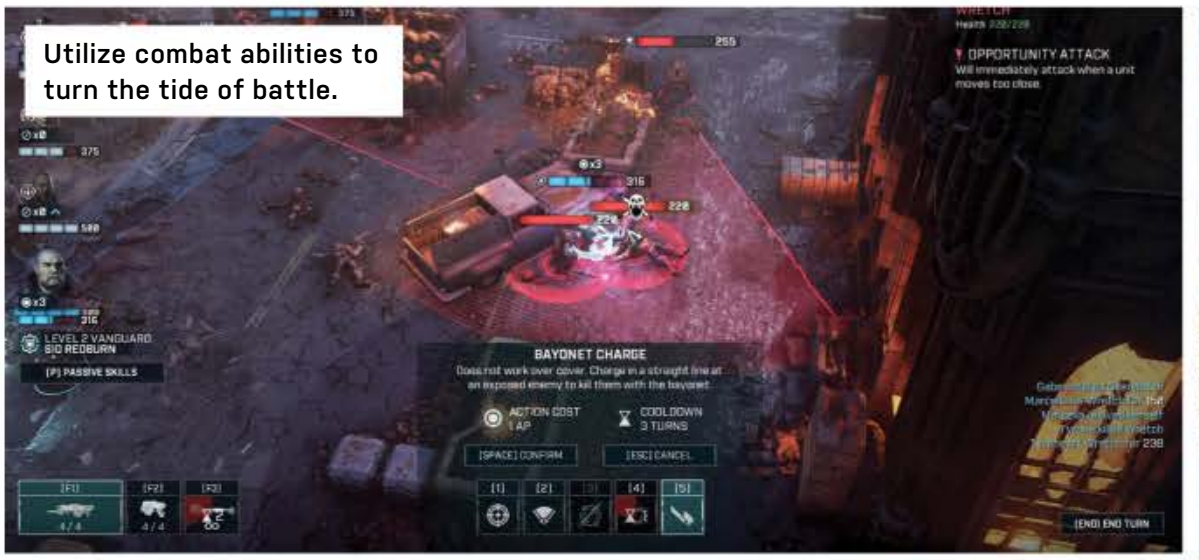
BUCOLIC Gorgeous hex-based worlds, complete lack of combat.

SHAMBOLIC Whales appear too late, roads can frustrate.

RECOMMENDED SPECS CPU, Intel Core i5-9400 or AMD Ryzen 5 3400X. RAM, 8GB. GPU, Nvidia GeForce GTX 970 or AMD Radeon RX 590.

$20, balancingmonkeygames.com, not rated

© BALANCING MONKEY GAMES



Utilize combat abilities to turn the tide of battle.

The Locust Horde—AKA chainsaw fodder.

Use Action Points to mow down incoming Locust drones.

Combat is centered on turn-based action.

TACTICAL TURN-BASED STRATEGY

Gears Tactics

Do you know the way to Fenix Point?

START OUT IN A GAME like *XCOM*, and you feel fragile: You don't have the advanced plasma weapons of the invaders; you don't have proper armor; your troops are a raggedy bunch of freedom fighters who were lucky enough to still be alive. Start out in *Gears Tactics*, for all it may look like *XCOM* to the casual observer, and you immediately feel powerful: You've got the series' trademark weapons; you've got the cover system; you're a side of beef crowbarred into a gridiron uniform.

This is just as well, as *Tactics* is prepared to stack the odds against you. Things move along in standard tactics game manner, with each soldier having a small number of Action Points with which to do stuff like move, fire, and reload. Run out of points, and the enemy gets its turn. The Locust Horde lives up to its name, and you'll need to make use of the melee execution system to overcome it. These kills, meted out to enemies who have dropped to their knees after taking damage, have the side effect of giving the rest of your squad an extra Action Point—only the executioner misses out. If you manage to chain enough executions together, you can keep your turn going for quite a long time.

It's a system that can literally turn the tide of battle. The right execution at the right time can rejuvenate a squad that has been locked to cover by overwhelming fire—the little cutscene while they're chainsawed in half or bashed in the head with a pistol butt is far less reward than the immediate return of your motivation. Maybe that one point is enough to allow a sniper shot? The sniper rifles in *Tactics* are particularly effective, especially if you undertake some of the side quests to upgrade them.

Unlockable abilities play on these Action Points further, transferring them between soldiers, and winning points back when comrades get kills. An Overwatching soldier with three points in the bank can fire three times. Heavies get an extra point just for going into Overwatch. Add to this the ability to revive downed teammates multiple times (unless on the very highest difficulty setting), and you've got a game that challenges without overwhelming, and provides enough positive feedback to keep you coming back.

This fabulous combat system is melded to a completely linear campaign, which sadly provides little replay value. And then there are boss fights: Big enemies with massive health bars who don't change their tactics once during protracted battles. Side missions aren't really "side" at all, as you need to do them—their rare weapon rewards are just too powerful and tempting to ignore. Loot from missions quickly becomes a chore to sort through, however, and without any kind of choice on your part on how to proceed next, the game can start to feel a bit flat long before it's over.

Gears Tactics so nearly gets it—the combat system, with all its playful abilities and feeling of being absolutely unstoppable, is an absolute highlight—but the game needs more player agency while out of combat to truly take on the titans of tactics games. **–IAN EVENDEN**

VERDICT **8**

Gears Tactics

GEARS Chainsaw bros with a clever combat system.

FEARS Boredom can set in out of combat.

RECOMMENDED SPECS CPU, Intel i5 Coffee Lake | AMD Ryzen 3. RAM, 8GB. GPU, AMD Radeon RX 570 | Nvidi GeForce GTX 970.

$60, gearstactics.com, Rated M

© XBOX GAME STUDIOS

LAB NOTES

CHRISTIAN GUYTON, STAFF WRITER

Black Lives Will Always Matter

We don't get political, but it shouldn't be political to say it

IT'S HARD TO SEE what we're seeing right now. And yet, we can't look away; we have a moral obligation to watch, to learn, and when we can, to help. I won't get bogged down in looting vs protesting, of black vs white. I'd call the events we're watching unfold "unprecedented", but that would be an insult to the black citizens who have been experiencing this sort of discrimination and abuse for centuries.

The public are angry, and justifiably so, and we at *Maximum PC* cannot stand by and be silent while all this goes on. If you are one of our many black readers, know that we stand with you. If you are not, I am personally calling on you to be on the right side of history. You can always do more to amplify the words of the marginalized and oppressed. Sign petitions, share resources, donate, attend peaceful protests, write to your elected officials, support black businesses and communities, read, research and learn about everything that's going on, even when it's hard to bear witness. Reach out to your black friends, colleagues, relatives, and ask what you can do to help. At *Maximum PC* we're also going to be making a concerted effort to build a more diverse base of writers. If you're a black tech writer, please reach out to us so we can talk about getting your work in the magazine on a regular basis.

I myself have been attending peaceful protests and donating to good, reputable causes too, and I encourage you all to do the same: the NAACP, Freedom Fund and International Justice Mission are all good places to direct your funds and speak up for justice and equality with your wallet. Even better, do some research into supporting local charities that are assisting those hurt and displaced by police violence.

As I write this, the protests are growing even larger, and police and government bodies are finally starting to capitulate to the demands of the people for their human rights to be upheld and respected as they deserve. I desperately hope that by the time you read this, we'll have started to see genuine, long-lasting, and positive change in our society. That said, our work may never be done; we must never be complacent, or cowed, we must never be silent. It's time for this nation and its police force to be held accountable for its actions, no matter what. Racism has absolutely no place in our incredible PC-building community in any capacity, or here at *Maximum PC*. Black lives matter.

INDUSTRY INSIDER

When will the 4000 series of Ryzen processors arrive? AMD isn't giving away much, and there's a lot of conflicting information out there. A recent report from *DigiTimes* has indicated that Ryzen 4000 may be pushed back as far as 2021, since the 3000 series is still selling like hotcakes and AMD apparently doesn't feel too threatened by Intel's Core 10,000-series opposition.

AMD likely still has a good chunk of the market share thanks to Ryzen's excellent price-per-thread ratio. Sales have been decent, and there's arguably no need for AMD to bloat the market space by throwing out Ryzen 4000 too hastily. Another six months in R&D could prove beneficial. The existence of upcoming 3000XT processors supports the claim that the Ryzen 3000 life cycle is being extended by AMD due to strong sales.

Does it need six months? A Twitter user demonstrated one of the new 4000-series laptop chips running through the *Crysis* benchmark without CPU cooling. The chips seem in a good place efficiency-wise, so releasing a small new range and retiring some 3000-series processors could be a smart move. AMD seems ready to release the new CPUs in late 2020, along with the new RDNA 2 GPUs, as confirmed by CEO Lisa Su. Will they be released in time?

© GETTY IMAGES

T2 Road Warrior Gaming Chair

FROM SOMETHING SO IMPORTANT to something so ridiculous. I do feel bad about it, but what I will say is I support Christian and that piece wholeheartedly, although you probably guessed that from my Editor's Intro anyway.

For this month's Geek Tested I've got in one of these fancy-schmancy gaming chairs from Corsair: The T2 Road Warrior (honestly, who thinks up these names?).

Now I consider myself a bit of an expert on PC chairs. Thanks to my turbulent upbringing I've sat on every kind of chair you could possibly imagine during my time with PCs. When I was very young I had a comfortable padded chair. When my parents first split up and mom moved out, we didn't have a lot of cash, so I ended up with a folding steel chair like this: https://bit.ly/MPCchair.

Fast-forward two years, and mom emigrated to New Zealand and I was back living with my old pops, sat on the world's most uncomfortable wooden desk chair, no padding, just wood—long gaming sessions would usually be accompanied by one or two pillows off of the bed. At university things changed again; my first dorm room (thankfully not shared) had a standard office chair, I'm guessing from the 1990s, which I couldn't do anything with. I moved out in my second year, and working as a barista in Starbucks I had a bit more change and bought myself a sophisticated executive-style office chair. It had minimal padding, and over long periods was also uncomfortable. In my final year I bought a cheap, nasty gaming chair from Amazon. It worked well, and got me all the way through that final year, through my job-hunting days, and into *Maximum PC*. Yeah, it might be a bit sad I can remember all those chairs.

Since then I've tried close to six different "true" gaming chairs from bespoke brands. Noblechairs' offerings are the best I've found, but at prices that make the RTX 2080 Ti look like a good deal.

When Corsair approached me with the offer to review one of its chairs, I took a leap of faith. And it's been a good experience. The T2 Road Warrior, despite the ridiculous name, is very comfortable, ergonomically well-designed, and there's a few neat touches too. For instance, all the screw holes on the sides are covered with padded rubber plugs with the Corsair logo on. The arm rests have a carbon fiber-esque smooth finish, and the padding in the seat is soft (jury's out on whether that's better or worse for your body). Things I'm not so convinced about are the wheels and the chair seat. The wheels in particular are very smooth and move ridiculously easily across laminate flooring. My puppy managed to push the empty chair the entire way across my office the other day with a single tap of her paw. The seat is designed in a similar manner to a bucket seat, so it holds you in position. I like to fold my legs at the desk, but it's not easy to do with that. My Noblechairs Icon has a wider, flatter base, so is better for leg-folding.

At $400 the Corsair T2 is a pretty good all-round chair, comfortable and stylish too, but more suited to a carpet or someone who has a chair mat. If you prefer squishy padding, then it may very well be perfect for you. **–ZS**

$400, www.corsair.com

© CORSAIR

EDITOR'S PICK

Zak Storey, Editor

CORSAIR HYDRO SERIES H115I RGB PRO XT

A few years back I built my old pops a gaming PC out of old spare parts I had lying around. It's a fairly humble rig: Intel Core i7-5820K, GeForce GTX 1080, 16GB of DDR4, all packaged up neatly in an NZXT H400i. He's been a big part of why I got into computing, and why I even started tinkering with them to begin with, and so I owe a lot to him.

The thing is, he's also a bricklayer and works damn hard. I mean I should know, I've done a bit myself as well, working alongside him. A big side-effect of bricklaying is that you get covered in dust, dirt, and cement, and it just ruins you. It also ruins hardware, particularly coolers. And so this lovely Micro-ATX rig of his has just about killed its third AIO. He comes home from work, jumps on the PC (which is coincidentally near his hobbyist mechanic garage, where he does up old VWs) for a few games of *World of Warships* (don't judge the man), and all that dust gets around inside the pump and eventually kills it. He's got through three pumps so far, and it does make me laugh.

So far he's managed to kill an engineering sample be quiet! 240mm AIO, a 240mm Corsair Hydro H100i, and now an NZXT Kraken X62. Yep, hardware-killing seems to be genetic. So what am I trying my luck with this time for him? Corsair's Hydro H115i RGB Pro XT.

It might not be quite as flashy as the Kraken X62, but it's a solid 280mm AIO liquid-cooler complete with some ML140 fans, an easy mounting mechanism for the LGA2011 socket, and some pretty swish aRGB as well, that I'll probably just turn off anyway. Hopefully it'll survive the rigors of my father's day-to-day work life, but only time will tell.

$140, www.corsair.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Control Panel
> Encrypted HTTP
> DIY Laptops

Tutorial Errors

Love *Maximum PC*. Been reading it for years. In the June 2020 issue "Breaking Back into Control Panel" I had forgotten about "GodMode." Well, I'm 75+, but it would have been handy last week. Thanks for your fine article.

Just a heads up—you forgot a hyphen in the folder name: "God Mode. {ED7BA470-8E54-465E-825C-99712043E01C}"

–Robert M & Steve Cook

EDITOR ZAK STOREY RESPONDS: I'll apologize in advance to you both Robert and Steve, I know we've bundled two of your letters together here, but we're just trying to save a bit of space. Thanks for pointing this out, sometimes these things do slip past us during the design and proofreading stage of issue development. I did check these links worked prior to sending it off to our art division, but clearly should've checked again once it was laid out on the page. Sorry about that! All on me for sure, but I'm glad to hear at the very least the article has helped a few folk out.

The Control Panel is still a huge bugbear for me at the moment. I've actually had to reinstall Windows 10 twice on my home workstation PC this past month, and navigating around and setting up my sound options for various devices has been a constant point of frustration, as Windows Search continually pushes me to that gratuitous, unhelpful "modern" Settings menu. Eugh.

Anyway, thanks for writing in, and I genuinely appreciate it when folk point out mistakes like this, as it means we can address any issues here.

HTTP not HTTPS?

I found it strange that in the "Best Free Software of 2020" section of the May edition that all the software is being delivered using HTTP. Hmmm. I wonder why that is. Thanks for a great mag. **–Len Babin**

EDITOR ZAK STOREY RESPONDS: That's quite an interesting point, no doubt on the supplier's end it must be in part because they want to get numbers about how many people are downloading their software. Although understandably, there's some privacy ramifications because of that. We always recommend that you use a browser extension to encourage HTTPS usage across sites that support it, even when they default to HTTP. That way you know you've got a bit more encryption and privacy compared to without it. HTTPS Everywhere is my go-to browser extension for that, for Google Chrome you can find that here: https://bit.ly/ChromeHTTPSE and for Firefox you can pick it up here: https://bit.ly/FirefoxHTTPSE

For those that don't know, HTTPS adds a layer of encryption between the host and the user, so any information or data you transfer across to a website is encrypted from any third parties who might somehow have access to that information.

When You Can't Get Online

Hi *Maximum PC* team. I just wanted to send a huge thank you your way. I recently got out of prison after four years, and your magazine was a godsend. I found a tattered copy in the prison library and immediately subscribed. Not only did I stay informed about new tech and software, but I learned an immense amount of stuff I was clueless about previously. My purchasing feels well-informed, and I still can't wait to get my next issue. Two special shoutouts: One to Joanna Nelius, I've loved your articles and reviews in this and the sister gaming mag. I feel like a kindred spirit as I also spent many years and much money studying English Literature and mention it regularly. I was sad to see your "see ya later" piece.

Second, to Zak, glad you're back, and way to go

[CORRECTION]

CANNON LAKE CONFUSION

Sadly we have to report a mistake that we made last issue. This dummy Editor here accidentally referred to Intel's latest processor's architecture as Cannon Lake. This is incorrect: It's actually formerly known as Comet Lake. Cannon Lake was a 10nm die shrink based off of the Kaby Lake architecture, typically used in low-powered devices in mid 2018. We apologize for this mistake.

–Zak Storey

↘ submit your questions to: comments@maximumpc.com

representing beards and Man-Genta! I have one potential article suggestion: AIO machines. I love the form factor and maybe they could get some love in a lean issue. Keep up the good work and know that the print magazine makes a lot of people smile who can't get to tech sites.

–J. LaFavor

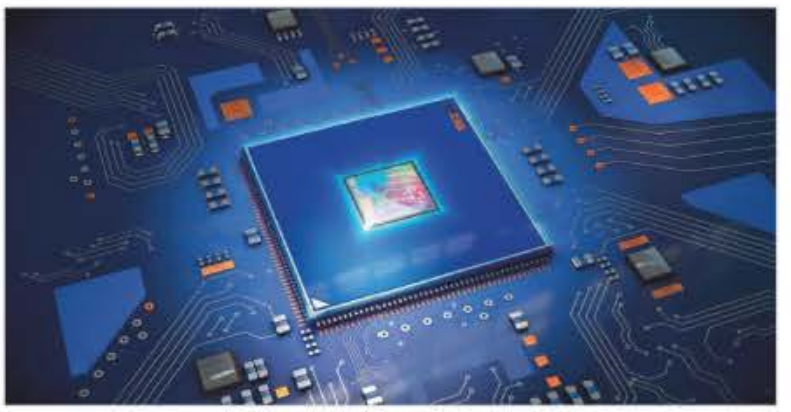
EDITOR ZAK STOREY RESPONDS: Thank you for your kind message, I've forwarded this on to Joanna as well, as we still stay in touch, despite the fact she works for the competition now sort of... (*Gizmodo US* for those curious). I'm also glad to hear that we're reaching folk in prison too, always nice to know we're helping educate people and keep them in the loop wherever they are. I remember actually receiving an email from a sailor deployed overseas, telling me about his gaming setup out there, and it genuinely blew my mind what this dude had. But it's nice to know that *Maximum PC*'s getting out to folk from all walks of life.

Also you'll be sad to know, the beard's gone. I'm a bit impulsive sometimes, I was having a particularly rough day, and when things like that happen, I usually try and do something dramatic just to refresh myself. So the beard came off (I still have stubble, otherwise I just look like a giant baby), but yeah. Between you and me, the aim is to one day have a proper Viking beard, but it's just too patchy at the moment at the front, which frustrates me, so I may wait a couple of years until I grow one out again. I've got a terrible hairline and shave my head weekly, so having a beard actually gives me something to look after.

In regard to AIO builds, it's not something we've looked at in-depth before. I'm guessing you mean builds baked into a screen as well? I know you can do custom systems like that, but they're difficult to really source the cases for. Most typically fall under the form of a high-powered NUC that can be VESA mounted, but then you can be limited by the monitor as well, as you need one with a stand that's not connected to those four VESA points. We'll do some research on that and get back to you. But thanks for still reading and supporting us, we appreciate it, and it means a lot in these trying times.

[NOW ONLINE]

INTEL'S TURBO BOOST MAX TECHNOLOGY 3.0



Not all CPU cores are created equally, and that applies to Intel's silicon, too. The silicon wafer fabrication process lends to discrepancies between each core's voltage, power, and thermal characteristics that lead to better performance. These faster cores are identified to the operation system as a favored core. The term "favored core" first came with the arrival of Intel's Broadwell-E line of HEDT (high-end desktop) CPUs in 2016.

Read the full article here: https://bit.ly/IntelTurbo3

DIY Laptop-style PC

From recent YouTube videos and forum posts, I infer that it is currently impractical to attempt to build your own laptop on a $700 budget. At that price, you can routinely assemble a DIY ATX PC, which includes 32GB RAM, a keyboard, a mouse, a 24-inch monitor, a Wi-Fi card, fast (e.g. SSD) storage, and a slow (e.g. mechanical) 1TB hard disk. I regard it as reasonable to exclude the OS, since the OS is typically hardware independent, and since the choice of Windows, Linux, or a Hackintosh is very personal.

Obviously, for ATX, the DIY approach has four advantages: 1. By hand-picking the parts, you can look for bargains and use quality parts that dovetail nicely. 2. By hand-picking the parts, you can plan a reasonable upgrade path. For example, you can choose a mobo+CPU combo that facilitates onboard video, exclude a video card, but start with a 550W PSU. This way, if you later decide to add a video card, you won't have to replace the PSU. 3. With pre-built PC's there is no avoiding the potential for poorly built PCs with (for example) a wiring problem that will go bad in two years. Based on forum posts and Amazon reviews, poorly built laptops are not uncommon. 4. A pre-built ATX PC that replicates the parts and build quality of your DIY ATX PC might cost double.

I think that the DIY approach needs to be brought to the mini-ITX case size, or the smallest feasible case size that can be used to replicate the portability of a laptop. I request that *Maximum PC* research the issue and then publish a corresponding article. The whole point would be to create the functional equivalent of a laptop that realizes the four advantages above.

–Steve S

EDITOR ZAK STOREY RESPONDS: Oh this is a tough one, we've shortened down your email, but just as you rightly point out throughout there's a lot to cover, including case-mounted screen, battery, integrated keyboard and such. To my knowledge it'd be incredibly difficult to find a chassis that could possibly do this straight off the bat. There's nothing really out there that you could do this with. It would require some extensive modding, and even a custom case.

There's definitely some super small form factor chassis out there. The Louqe Ghost S1 comes to mind, and there's a fair few HTPC (home theater PC) cases out there that might fit the form factor a bit better too, but there's definitely some ergonomic constraints to achieving what you're after, especially in regard to having a keyboard fixed to a chassis like that. The slimmest case I know of is Streacom's FC5 ALPHA Fanless chassis, which comes in at about 2.36 inches tall, but it's also $270, which eats up your $700 budget immediately. The sad fact is a lot of desktop hardware is designed very specifically to be run in tower cases—CPUs included—so trying to find something slim enough, with enough cooling capacity to manage a desktop processor and hardware in general, is the challenge. The battery situation is even more difficult.

Sadly I'm just not sure it's possible. It's quite a niche field, and because of that the market just hasn't developed the hardware to take advantage of it. The best solution if you're still after that portability would be a custom-built NUC or Gigabyte Brix, powered by a USB Type C port. Bundle that with some slim peripherals, a portable monitor, and the biggest battery bank you can get, and you'd be looking at a winner. But sadly I don't think there are any NUCs out there right now that are powered by USB C either.

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THE BUILDS

BUDGET

THERE'S QUITE THE HIKE on power supply prices this month we're afraid. But in the interest of variety we've got two different options for you, both at 450W: The MWE 450 V2 from Cooler Master in our budget AMD system, and the CX450 from Corsair in its Intel counterpart. The V2 is a bit cheaper, but the CX450 has a better efficiency rating (80+ Bronze vs the V2's 80+ White certification), so it's up to you to decide what you want to spend your money on.

Motherboards proved a pricey problem for our AMD build, where we've had to swap over to the Asus Prime B450M-A, a slightly smaller Micro ATX board than the previous MSI Pro B450M. Bear in mind that if you don't buy the Asus mobo new, you may need a 2nd-generation AMD CPU in order to flash the BIOS for Ryzen 3000 compatibility. We're not changing much else on the AMD build, though. The 120GB SU650 drive from Adata has dropped in price again, making it an absolute steal at just $20.

We're shaking things up a bit more over in the Intel machine. First up, the previous motherboard is no longer on sale, so that's gone. Replacing it is another Asus Prime board, the eye-catching Prime Z390-P. We're shaving $10 off the overall price by switching over to EVGA's single-fan GTX 1660 Super Black Gaming, then a few dollars more by changing up the memory for G.Skill's Ripjaws V Series RAM at the same capacity and speed we had before.

We're sticking with the SU650 SSD and Seagate Constellation ES HDD for both builds, as both have dropped in price since our last issue, and together they're pretty much the best budget storage available right now. Neither processor will be changed either for now, but watch this space. With the Intel Core i5-10600K now available, we'll be planning an upgrade to this build soon, but right now those chips are entirely sold out, so we'll have to wait. The 10600K costs a fair bit more than its previous-generation counterpart, and we might need to upgrade the motherboard too.

AMD INGREDIENTS

PART		PRICE
Case	BitFenix Nova TG	$69
PSU	450W Cooler Master MWE 450 V2 NEW	$62
Mobo	Asus Prime B450M-A NEW	$136
CPU	AMD Ryzen 5 3600	$167
GPU	ASRock Challenger D RX 5600 XT 6GB	$270
RAM	16GB (2 x 8GB) Team T-Force Vulcan Z @ 3,000MT/s	$60
SSD	120GB Adata SU650 2.5" SATA III	$20
HDD	1TB Seagate Constellation ES ST1000NM0001 HDD	$31
OS	Ubuntu Desktop Linux 18.04 LTS 64-bit	$15
Approximate Price:		**$830**

INTEL INGREDIENTS

PART		PRICE
Case	BitFenix Nova TG	$67
PSU	450W Corsair CX450 NEW	$69
Mobo	Asus Prime Z390-P NEW	$125
CPU	Intel Core i5-9600K	$210
GPU	EVGA GeForce GTX 1660 Super Black Gaming 6GB NEW	$230
RAM	16GB (2 x 8GB) G.Skill Ripjaws V Series @ 2,400MT/s NEW	$59
SSD	120GB Adata SU650 2.5" SATA III	$20
HDD	1TB Seagate Constellation ES ST1000NM0001 HDD	$31
OS	Ubuntu Desktop Linux 18.04 LTS 64-bit	$15
Approximate Price:		**$826**

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MID-RANGE

ANOTHER MONTH, another price drop on the Ryzen 7 3700X. It's one of the best-value processors right now, packing 16 threads, PCIe 4.0 support, and a pretty respectable Wraith Prism RGB cooler. We're not using that cooler here, though: Instead, we're sticking with the Corsair A500, which is $10 cheaper than last month. The MSI Radeon RX 5700 is the best-value 5700 model on the market, but it cancels out our cooler savings by rising in price by $10.

We've taken our CPU savings and decided to upgrade the memory, opting for a twin-stick Corsair Vengeance LPX kit. This has the same memory capacity and frequency as the Vulcan Z RAM it replaces, but thanks to a lower CAS latency we should see an improvement in real-world memory speed. We're sticking with the same drives though, as the Corsair Force MP600 remains the most affordable of the limited selection of PCIe 4.0 drives available. Hopefully we'll see more super-speedy SSDs once Ryzen 4000 chips arrive, although rumors of delays are circulating.

We're changing the PSU across both mid-range builds to the Corsair CX650, which should provide plenty of power for those power-hungry GPUs. On the Intel machine, we're changing out a few more components. We've upgraded the motherboard to the Asus ROG Strix Z390-F Gaming, a more robust board that includes a solid integrated heat sink for our WD Black SN750 M.2 drive.

While we've hung onto the Corsair A500 in our AMD system, we've saved a lot on the Intel CPU cooler with the eminently affordable Phanteks PH-TC12DX. It's pretty much the biggest saving we can make without sacrificing a CPU fan. The last change we've made is a GPU swap. We're sticking with the RTX 2060 for now (with a possible upgrade to a 2060 Super, but we'll look at upgrading the CPU first), switching to EVGA's twin-fan KO Ultra Gaming model. This won't provide much performance boost, but our previous GPU is no longer on sale, making this a better value proposition.

AMD INGREDIENTS

PART		PRICE
Case	Fractal Design Meshify C	$85
PSU	650W Corsair CX650 NEW	$85
Mobo	Gigabyte X570 Gaming X NEW	$170
CPU	Ryzen 7 3700X	$275
Cooler	Corsair A500 Dual Fan	$90
GPU	MSI Radeon RX 5700 8GB	$340
RAM	16GB (2 x 8GB) Corsair Vengeance LPX @ 3,000MT/s NEW	$78
SSD	500GB Corsair Force MP600	$115
HDD	1TB Seagate Constellation ES ST1000NM0001 HDD	$31
OS	Windows 10 Home 64-bit OEM	$100
Approximate Price:		**$1,369**

INTEL INGREDIENTS

PART		PRICE
Case	Fractal Design Meshify C	$90
PSU	650W Corsair CX650 NEW	$85
Mobo	Asus ROG Strix Z390-F Gaming NEW	$210
CPU	Intel Core i7-9700F	$322
Cooler	Phanteks PH-TC12DX NEW	$58
GPU	EVGA GeForce RTX 2060 KO Ultra Gaming 6GB NEW	$320
RAM	16GB (2 x 8GB) GeIL EVO POTENZA @ 2,400MT/s	$64
SSD	500GB Western Digital WD Black SN750 M.2 PCIe SSD	$80
HDD	1TB Seagate Constellation ES ST1000NM0001 HDD	$31
OS	Windows 10 Home 64-bit OEM	$100
Approximate Price:		**$1,360**

THE REIGN OF THE Threadripper 2950X is over! The Threadripper series has long been toeing the line between powerful and overpriced, and with the 2950X stockpile running dry, limited second-hand units are rising in price. So rather than opting for the prohibitively expensive 3rd generation of Threadripper processors, we're losing a few cores and going for the top-tier AM4 chip instead, the 16-core Ryzen 9 3950X. It's impressively powerful, but not towards the point of redundancy. This means we've had to swap out the motherboard, so we've opted for Gigabyte's X570 Aorus Ultra. Our cooler remains compatible with the new motherboard socket, so we don't have to change that up.

One upgrade we do have to make, however, is the SSD. The move to 3rd-gen Ryzen means we now have PCIe 4.0 support, and we just have to take advantage. To that end, we've got a 1TB version of the Corsair Force MP600 SSD, which isn't too much more expensive than the Seagate BarraCuda drive we had been using but offers incredible 5GB/s read speeds.

We're also changing up the HDDs in both builds, swapping to a single 6TB BarraCuda hard drive in favor of the dual 3TB drives, which has saved us over $30 on both builds. Both systems are also receiving the EVGA SuperNOVA 850 GA, as we were stung once again by rising PSU prices.

Over on our Blue Build (patent definitely not pending), the i9-9900K has dropped by a further $15. It's still one of the best gaming and multimedia-editing CPUs we've ever seen, so snap one up fast if you're looking to build a high-powered machine. We've also made a saving by swapping to the Asus ROG Strix Z390-H Gaming, since the previous mobo is out of stock at the time of writing. The funky Aorus RGB Liquid Cooler 280 has also had a significant price cut, which is a welcome sight. It's left our Intel turbo system over $150 cheaper than the AMD rig, which will perform on a similar level (better at rendering, somewhat worse for gaming). Hopefully next month we can shave a few bucks off the AMD machine too.

AMD INGREDIENTS

PART		PRICE
Case	NZXT H710i	$170
PSU	850W EVGA SuperNOVA 850 GA **NEW**	$220
Mobo	Gigabyte X570 Aorus Ultra **NEW**	$300
CPU	AMD Ryzen 9 3950X **NEW**	$700
Cooler	Corsair iCUE H115i RGB Pro XT 280mm	$140
GPU	Gigabyte GeForce RTX 2080 Super Gaming OC White 8GB	$740
RAM	32GB (2 x 16GB) G.Skill TridentZ RGB @ 3600MT/s	$180
SSD	1TB Corsair Force MP600 M.2 PCIe **NEW**	$200
HDD	6TB Seagate BarraCuda ST6000DM003 HDD **NEW**	$134
OS	Windows 10 Homes 64-bit OEM	$100
Approximate Price:		**$2,884**

INTEL INGREDIENTS

PART		PRICE
Case	NZXT H710i	$170
PSU	850W EVGA SuperNOVA 850 GA **NEW**	$220
Mobo	Asus ROG Strix Z390-H Gaming **NEW**	$279
CPU	Intel Core i9-9900K	$515
Cooler	Gigabyte Aorus RGB Liquid Cooler 280mm	$212
GPU	EVGA GeForce RTX 2080 Super Black Gaming 8GB	$768
RAM	32GB (2 x 16GB) Corsair Vengeance RGB Pro @ 2,666MT/s	$158
SSD	1TB Seagate BarraCuda 510 M.2 PCIe SSD	$169
HDD	6TB Seagate BarraCuda ST6000DM003 HDD **NEW**	$134
OS	Windows 10 Homes 64-bit OEM	$100
Approximate Price:		**$2,725**

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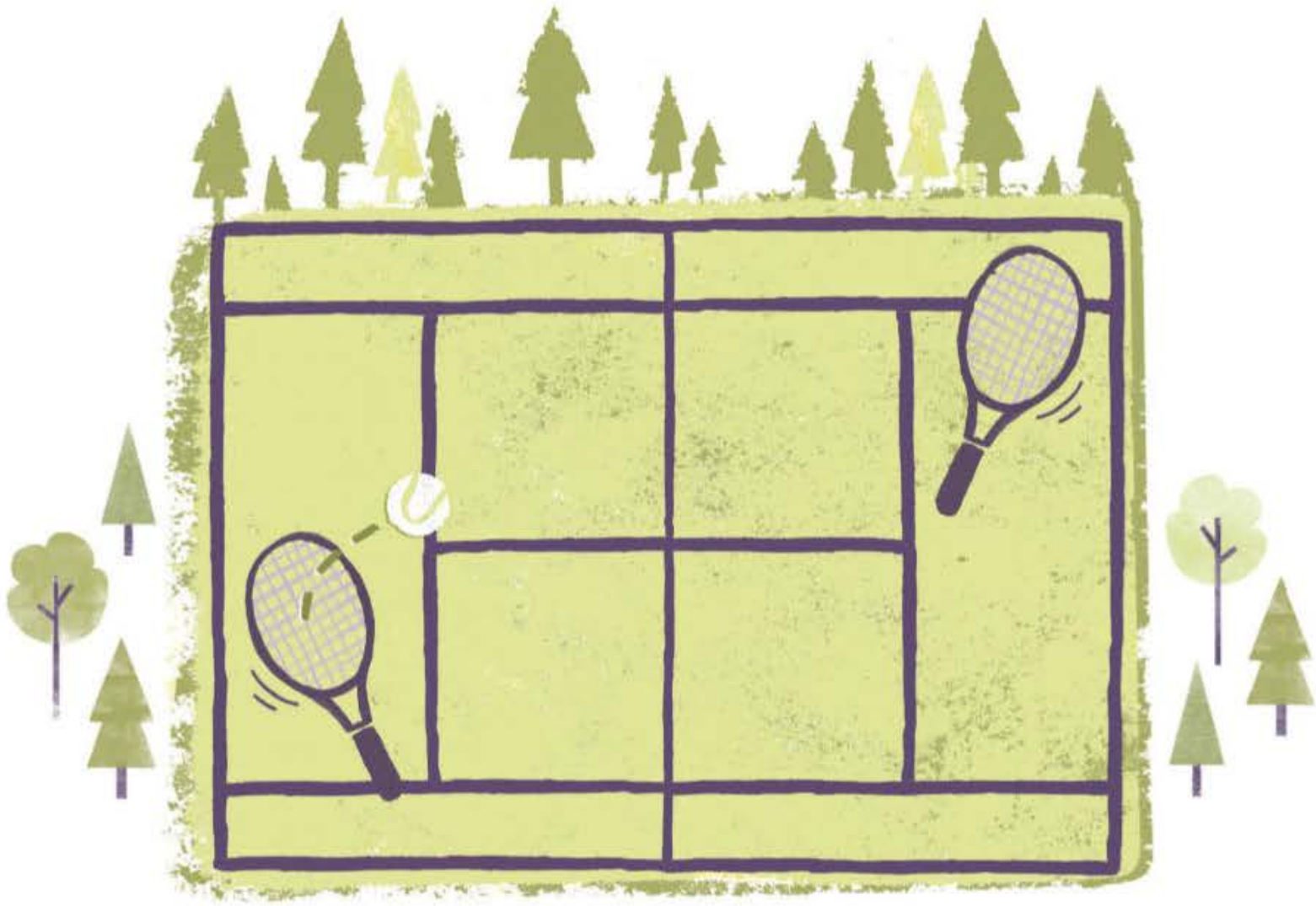

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